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The Mining Magazine

Scientia non habet inimicum nisi ignorantem.

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STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,998	363,826	8,794,824	37,358,040
July, 1914	703,136	29,349	732,485	3,111,398
August	684,607	27,311	711,918	3,024,037
September	677,063	25,107	702,170	2,982,630
October	703,985	29,761	733,746	3,116,754
November	685,450	30,386	715,836	3,040,677
December	669,075	26,062	695,137	2,952,755
Year 1914	8,033,567	344,570	8,378,139	35,588,075
January 1915	689,817	25,167	714,984	3,037,058
February	653,213	23,008	676,221	2,872,406
March	727,167	26,768	753,935	3,202,514
April	717,225	26,855	744,080	3,160,651
May	737,752	25,796	763,548	3,243,347
June	727,924	27,356	755,280	3,208,224

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
January 31, 1914	154,202	9,471	11,979	175,652
February 28	157,673	9,508	12,266	179,447
March 31	162,815	9,619	13,390	185,824
April 30	165,005	9,625	14,150	188,780
May 31	165,433	9,619	14,284	189,336
June 30	166,248	9,442	13,256	188,946
July 31	167,006	9,257	13,656	189,919
August 31	168,851	9,485	—	178,316
September 30	169,619	9,389	—	179,008
October 31	170,438	9,212	—	179,650
November 30	166,039	8,990	—	175,029
December 31	164,650	8,704	—	173,354
January 31, 1915	172,331	8,675	—	181,006
February 28	180,422	8,494	—	188,916
March 31	185,239	8,216	—	193,455
April 30	186,941	8,418	—	195,359
May 31	183,961	8,857	—	192,818
June 30	184,155	9,019	—	193,174

Cost and Profit on the Rand.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Year 1912	25,486,361	29 2	19 3	9 11	12,678,095
Year 1913	25,628,432	27 9	17 11	9 6	12,189,105
January 1914	1,902,733	27 4	18 2	9 3	876,577
February	1,861,442	26 10	17 11	8 10	823,654
March	2,094,098	26 4	17 3	9 1	945,000
April	2,075,561	26 6	17 3	9 3	955,600
May	2,196,287	26 3	17 0	9 3	1,011,968
June	2,178,161	25 5	17 1	9 5	1,025,629
July	2,281,717	25 10	16 9	9 1	1,032,562
August	2,261,800	25 5	16 8	8 9	988,567
September	2,188,939	25 11	16 9	9 1	989,859
October	2,301,795	25 8	16 8	8 9	1,004,264
November	2,192,365	26 3	17 0	9 0	982,346
December	2,167,056	25 11	17 3	8 6	917,662
Year 1914	25,701,954	26 6	17 1	9 0	11,553,697
January 1915	2,237,748	25 10	17 5	8 3	920,194
February	2,077,792	26 4	17 11	8 4	867,782
March	2,366,392	25 9	17 4	8 4	985,511
April	2,289,002	26 4	17 5	8 9	996,846

The above are the official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 70% of the working profit.

Production of Gold in West Africa.

Year 1912	Year 1913	Year 1914	May 1915	Year 1915
£1,497,179	£1,634,700	£1,727,044	£142,123	£733,554

Production of Gold in Rhodesia.

Year 1912	Year 1913	Year 1914	May 1915	Year 1915
£2,707,368	£2,903,267	£3,530,207	£318,898	£1,514,047

Gold Output of India.

Year 1912	Year 1913	Year 1914	June 1915	Year 1915
£2,265,094	£2,299,315	£2,340,259	£197,547	£1,185,649

Production of Gold in Western Australia.

	Export oz.	Mint oz.	Total oz.	Total value £
Total, 1913	86,255	1,227,888	1,314,143	5,582,140
July, 1914	8,294	88,305	96,599	410,324
August	101	102,346	102,447	435,164
September	1,535	103,577	105,112	446,485
October	2,028	99,366	101,394	430,692
November	1,217	109,282	110,499	469,387
December	1,214	101,534	102,748	476,253
Total, 1914	51,454	1,181,520	1,232,974	5,237,308
January 1915	561	98,196	98,757	419,495
February	607	103,661	104,258	442,900
March	1,829	91,872	93,764	398,282
April	1,017	101,592	102,609	435,853
May	2,311	101,359	103,670	440,360
June	1,273	100,036	101,309	430,333

Other Australian Gold Production.

	1913	1914	June 1915	1915
	£	£	£	£
Victoria	1,847,400	1,740,300	134,200	681,400
Queensland	1,118,610	1,011,310	90,500	546,460

Exports of Copper from United States

(Reported by United States Customs).

Month	Long Tons	Month	Long Tons
July, 1914	34,145	January, 1915	28,197
August	19,676	February	12,066
September	23,866	March	29,725
October	28,995	April	20,481
November	20,170	May	25,785
December	16,830	June	15,751

Nigerian Tin Production.

In tons of concentrate of unspecified content.

Year 1912 tons	Year 1913 tons	Year 1914 tons	April 1915 tons	Year 1915 tons
2,532	5,032	4,832	444	1,637

Production of Tin in Federated Malay States.

Estimated at 70% of concentrate shipped to smelters.

1911 tons	1912 tons	1913 tons	1914 tons	May 1915 tons	1915 tons
43,967	48,250	50,128	49,042	3,823	19,270

Sale of Tin Concentrate at Redruth Ticketings.

	Tons	Value	Average
Year 1911	6151½	£702,599	£114 4 5
Year 1912	6492	£831,908	£128 5 6
Year 1913	6186	£744,268	£120 2 6
Year 1914	4987	£432,437	£86 14 3
January to June 1915	2826	£261,958	£92 13 10
July 5	202	£18,721	£92 13 5

Imports of Tin Concentrate into United Kingdom.

	June		Year 1915	
	Tons	Value	Tons	Value
		£		£
Bolivia	4,390	353,179	20,516	1,721,386
Other Countries	431	37,780	4,642	440,053
Total	4,821	390,959	25,158	2,161,439

REVIEW OF MINING

INTRODUCTION.—Financing the war is the big problem of the present, and has attracted major attention throughout the past four weeks. It is recognized that upon Great Britain must fall the chief burden, and the Government have accepted it. A national campaign for saving has been inaugurated, it being agreed that one must "practise thrift or else you'll drift." A great war loan was offered to the public on June 21, and has proved widely popular. Necessarily, the money must be raised mainly within the Empire, since the Allied countries themselves need financial help. The neutral countries, apart from the United States, have no large sums available. Sentiment there is widely favourable to the Allies, but the people are not educated up to making foreign investments, and the returns offered, having regard for the deduction of income tax, are not such as to compete with local securities. It is extremely desirable, in order to steady exchange, that American money should be made available for European credits, and a way has been found to do this. Briefly, European banks and individuals are borrowing from America, pledging American securities held abroad, and are investing the borrowings in war loans. At the same time, British banks are calling in loans based upon American securities, thus forcing their sale. The New York market seems able to absorb all that are offered. Thus, a difficult situation is being met along sound lines. Meanwhile, the Germans are, through war levies, draining local money out of Belgium and spending it in Holland, substituting their own paper in Belgium. They make about 5% on the transaction, since in neutral countries Belgian promises to pay are rated higher than German; thus proving again that honesty is the best policy. Metals continue at high prices, and copper, lead, and zinc, stand at about the positions held a month ago. Buyers have, however, recovered from their panic, and business faces the prospect of another year's war, distasteful as it is, with calm assurance. Welcome rains have come to Australia, crop reports both in Europe and America are excellent, and business conditions, outside the countries at war, are so much better that investment of surplus funds must soon become active.

TRANSVAAL. — One result of General Botha's campaign in what was German South-West Africa is a new route to the Rand, as Warmbad is now linked to Prieska by means of a military line. This will doubtless be reconstructed to fit it for regular traffic, and Walfish Bay may soon become a halfway house on the route to Johannesburg. The resulting influx of engineers and others will doubtless lead to rapid development of the new state, which might fittingly be renamed 'Bothaland.' We discussed the territory in some detail last month.

The output of gold on the Rand during the month of June was 727,924 oz., and in the outside districts 27,356 oz., making a total of 755,280 oz., worth £3,208,224, as compared with 763,548 oz., worth £3,243,347 during May. The number of natives employed in the gold mines on June 30 was 184,155, as compared with 183,961 at the end of May, and 166,248 on June 30, 1914.

The total dividends declared on the Rand for the first half of the year 1915 amount to £3,845,000, a fall of £210,000 as compared with the corresponding distribution a year ago. Last year the Robinson dividend included a bonus of £275,000. Village Main Reef, being near its end, has only distributed 20% as compared with 35%, and the rate at Crown Mines has fallen from 55% to 35%. Bantjes has not been able to distribute a dividend, owing to the damage to the shaft by floods early in the year. New Goch has returned to the dividend payer's list, as has also Randfontein Central, the latter distributing 2½%.

Modder Deep has declared its first dividend, an interim distribution of 10% being made for the first half of 1915. At the meeting of shareholders held in Johannesburg, the chairman, Mr. H. Newhouse, had a highly satisfactory statement to make, and unlike some chairmen, presented it in a clear and concise manner. After two bore-holes had proved the existence of profitable banket, sinking was commenced in 1910, one shaft entering the reef in August 1912, and the other two months later, the depth being about 3000 ft. The mill was started in the middle of December 1914. It is worthy of note that the estimate of capital expenditure, £708,115, proved to be substantially correct, and that the small excess of the actual figures is accounted for chiefly by the better provision for the housing of the native labourers. Moreover, the mill was actually ready before the specified date. The accession of this mine to the dividend-paying list, and the improved position at Geduld, have restored the prestige of the controlling house, A. Goerz and Co., which had latterly suffered from bad luck in connection with its Rand ventures.

At the annual meeting of the Brakpan company held last month at Johannesburg, Mr. E. J. Renaud, a director representing the Central Mining-Rand Mines group, paid a well deserved tribute to the retiring chairman, Mr. W. L. Honnold. Mr. Honnold, as consulting engineer, was responsible for the plan of development of this deep-level property in the far east Rand, and his sagacity has been amply proved by the results attained.

RHODESIA.—The output of gold during May was worth £318,898, approximately the same figure as in April, and comparing with £290,062 in May 1914. There were a large number of small increases over April, but Golden Kopje and Lonely Reef showed substantial falls.

The Falcon copper-gold mine, controlled by the Consolidated Gold Fields of South Africa, is fated to be dogged by disappointments and disagreeable episodes. In our March issue we quoted the directors' statement that the recoveries of copper and gold had risen from 80·9% and 85% respectively at the start, to 81·6% and 91·1% by the end of 1914. Now comes a long delayed 'quarterly' report, covering actually three-quarters, in which it is stated that the first monthly returns of metals produced, for August last, showed recoveries of 50·7% and 45·6%, and that by December the recovery had improved to 64·2% and 72·3%. The figures for March were 71·2% and 69%. The two sets of figures exhibit a wide discrepancy. The figures now published relate to the actual copper and gold produced as blister copper, and it is possible that those in the yearly report related to the concentration operations. In this case the smelting affords large scope for improvement. But the company would do better to publish further details and clear up the doubts that are bound to exist under the circumstances.

The Shamva paid its first dividend in April, when 5% was distributed. A second dividend, of 7½%, was announced this month, making 12½% for the first half of 1915, the amount disbursed being £75,000. The current quotation of the £1 shares is 44s. The ore reserve is about 2,100,000 tons, averaging 5 dwt. per ton, and development in depth indicates a rapid contraction in the size of the orebody. The monthly output is about 50,000 tons, so that the reserve will last 3½ years. The average recovery is 80%, and the working cost about 7s. 6d. per ton.

WEST AFRICA.—The gold produced during May was worth £142,123, as compared with £149,978 in April and £145,227 in May 1914. Prestea Block A, Broomassie, and Abosso exhibited decreases, but Abbontiakoon showed an increased output both gross and per ton.

The directors of Prestea Block A announce that the outstanding loan is approaching liquidation, so that shareholders may expect to receive their long-delayed first dividend some time next year. The ore reserve is estimated at 646,610 tons, averaging 38s. 6d. per ton, and the probable extraction, pending the treatment of slime, will be about 31s. 6d. The working cost during 1914 was 25s. 6d. per ton. The share capital is £1,049,876. Obviously, therefore, the dividend when it does arrive will be at a low rate per cent. The graphitic schist still causes trouble in cyaniding, and, unfortunately, the lower the grade of the ore the less is the proportion of amalgamable gold.

The Benue dredge has not been a success, for the ground for which it was designed is not only clayey, but bakes and hardens to such an extent during the dry weather as to be unworkable. The company is intending to increase the proportion of calabashing done. Money is required for the purpose of paying the final instalment of the price of the dredge and for current expenses, so the company is to be reconstructed, reducing the 60,000 £1 shares to 10s., carrying a liability of 1s. per share.

AUSTRALASIA.—Heavy rains have saved the situation, as the Commonwealth had been reduced to importing food, and with large war expenses and a drought times would have been bad indeed. As it is, everyone is smiling. Action has been taken to cancel the German zinc contracts, and to protect the companies against subsequent claims for damage. This will cover the case of Australian companies, and probably also of English companies signing contracts in Australia. In the meantime, Broken Hill Proprietary is enlarging its zinc smelter 30% and experimenting with zinc ribbon as a substitute for zinc shavings in cyanidation. Sheet for making shavings has always been imported. As the ribbon is easily and cheaply made by pouring a stream of molten spelter on a water-cooled drum, it can be at once substituted if found acceptable. Progress in enlarging the lead smelter is rapid. It was announced on July 6 that the Broken Hill Associated Smelters Proprietary Limited would be ready within two weeks to treat 3700 tons of concentrate per week, and that within six months the plant capacity would be raised to 5000 tons, which, it may be noted, would still be below the total Broken Hill output, though well on toward realization of the plan of mobilizing Australian lead production.

Last month we reported that Amalgamated Zinc (De Bavay's) had sold 7500 tons of zinc concentrate to American smelters. Since then, 50,000 tons has been sold for delivery to America, and in addition 6000 tons has been sold for delivery at Marseilles. The Zinc Corporation announces that negotiations are in hand for the sale of 14,000 tons to America.

We are informed that the Great Cobar debenture-holders have subscribed all but a small portion of the £102,000 estimated as required to place the property in a working condition, as outlined in our April issue. The present high price of copper should hasten the completion of the reorganization.

During the year ended May 31 the production at Mount Morgan was 9075 tons of copper and 116,505 oz. of gold, and £150,000 was distributed as dividend. The copper sold during the half-year December to May brought an average price of £75. 8s. per ton. The geological examination of the mine by Mr. Colin Fraser has been completed. His recommendation to explore the Sugarloaf section has resulted in a substantial addition to the ore reserves.

The Hampden Cloncurry Company was badly hit at the outbreak of war, partly because the sale contract of the copper was in alien enemy hands, and partly because the fall in price extinguished all profit. It was necessary to restrict the output, and to ask the men to accept a reduction in wages. Cable advice is to hand announcing that the output of copper is to be increased, and that 280 to 300 tons of ore is to be treated per day. The scale of development operations is to be expanded. The financial position of the company is excellent and the payment of dividends will be resumed in August. It is announced that at the Duchess mine, ore averaging 25% copper over 48 in. has been found on the 850-ft. level.

The Lake Margaret hydro-electric power has already had an important effect in reducing working costs at the Mount Lyell. Though the installation was only completed in November, the average cost of mining and smelting for the half-year ended March 31 has been reduced from 21s. 2d. to 18s. 6d. per ton of ore. In the North Lyell section, the results of development have been excellent on the 1000-ft. and 1200-ft. levels and 79,210 tons of high-grade ore has been added to the reserve. The company has made a contract to sell 250 tons of electrolytic copper every month to the British Insulated & Helsby Cables Company, of Prescot, Lancashire. Mount Lyell copper was sold to German buyers before the war.

The directors of the Great Boulder Perseverance recognize the necessity of considering a stoppage of development work. For some years little or no profit has been made, though the output and reserve of ore are large. During the last few months the ore broken has been below the profitable limit. The right policy appears to be to work such of the reserve as is profitable, and after its exhaustion in two years time, to abandon the property.

At the Great Fingall the stoppage for two months during last year, owing to the unsafe condition of the hanging wall, together with the cost of filling the exhausted stopes with sand, has had a disastrous effect on the financial results for 1914, the year ending with a debit balance of £25,821. It is interesting to note that the system of continuous decantation has been adopted for the slime plant in place of filter-pressing.

The development of Croydon goldfield is receiving the attention of the Queensland Government, and financial aid to the extent of £16,666 is being given to Mr. F. W. Cuthbert to help him to continue sinking the shaft on the Iguana Reef, providing he and his friends find £8333. This mine yielded large amounts of gold in the shallow levels, and diamond-drilling has proved the existence of an auriferous shoot at 1200 ft. The shaft is to be sunk to prove the ore thus indicated.

UNITED STATES.—The situation as regards flotation litigation remains unchanged, but we are informed that the American rights to the Elmore patents have been bought outright by an American group. While this forestalls possibility of litigation with the Elmores it probably forecasts a long fight between producers and Minerals Separation, regardless of pending cases. Our San Francisco correspondent notes the American antipathy to royalties.

The upward movement in metal prices has been checked, and both lead and spelter have fallen from their highest quotations, but the business being done is extremely satisfactory to producers, both as to price and quantity. Copper exports, naturally, are less than before the war, though there are compensations in price. The June shipments totalled 15,750 tons as against 34,820 in June 1914. Lead exports were but a trifle short of 5000 tons, whereas normally little lead is shipped abroad. The most striking change is in regard to spelter, which at times has even been imported by the United States. In the ten months ended April 30, including nine months of war, the United States exported almost 100,000 tons of spelter as compared with 1400 in the same period last year. This has severely strained the producing capacity of the country, and the United States Steel Corporation, which is the largest domestic buyer of spelter, has announced that it will build at once a plant near Pittsburg, capable of producing 40,000 tons of spelter per year and 80,000 tons of sulphuric acid. To supply this plant contracts have been made with Australian mines for zinc concentrate sufficient for one year and smelting is expected to begin in January 1916. This will place the Corporation in the front rank of zinc producers, since it already has in the Edgar Zinc Co., of which it owns 90% of the shares, a capacity of 30,000 tons. The Edgar plants are two in number, 4800 retorts at Cherryvale in the Kansas gas belt, and 2000 coal-fired at St. Louis, Missouri. The Edgar company has been a consistent buyer of high-grade Joplin ore, and it is indicative of a complete change of policy, foreshadowed in the retirement of Mr. Edgar which we announced in May, that the Corporation proposes to feed the new works with lower grade Australian ore. The steel trade is improving and even high-cost furnaces are going into blast. The United States Steel Corporation plants are now operating at 81% capacity. Various court decisions are removing doubt as to interpretations of the anti-trust laws and the wheels of industry are beginning to revolve. On the Pacific coast the Panama Pacific Exposition is still the main feature and is attracting satisfactory attendance. We note with pleasure that the International Jury of Awards has highly commended the exhibit made by the mining men and metallurgists, and has been liberal in distribution of awards to them.

Goldfield continues to show new bodies of high-grade ore and California mines are doing well. Plymouth Consolidated, indeed, is making such profits that an early and substantial dividend may be anticipated. In the oilfields low prices prevail, but the State has at last resolved upon determined efforts to control the influx of water in the oil sands, a very practical matter of conservation. The technical direction of the work has been placed in the hands of the State Mineralogist.

The Tomboy is paying a final dividend for 1914 of 1s. per share, making 3s. for the year. It had been expected that 2s. would have been paid, but several adverse circumstances prevented the realization of this hope. For one thing, the developments in the Montana section were for a time in comparatively low-grade ore which diminished the returns, and for another, the severe snowstorms of the early winter did damage and increased the working cost ; also, the new cyanide plant has cost more than was expected, and probably further expenditure will be required for the purpose of improving the extraction.

ALASKA.—Reports of the Treadwell companies appearing within the month show that the usual good work is being done with excellent results. Details are given in our 'Company Reports.' The plan published with the reports indicates that the shortening of the great ore-shoot continues at the new levels. While development at 2100 ft. is incomplete, and at 2300 only the station has been cut, so far it does not appear that there is a corresponding thickening of the shoot, as was true from 1400 to 1600 ft. in depth. It would seem probable therefore that the thickening then observed was apparent only and due to changes in dip. However, even if the area of cross-section is really decreasing in depth, the amount of workable ground is still large. According to the report of Mr. P. R. Bradley, the general superintendent, exploration at 2100 ft. shows, in Treadwell ground alone, on the south vein a block of ground 146 ft. through, and 327 ft. long, averaging \$3·25 in content. As the total average yield during the whole history of the mine has been \$2·46, and the cost last year was \$1·19, it is evident that the grade, if not the amount of ore on the lower levels, will prove satisfactory. Probably the new arrangements for central working will so lower costs as to permit treatment of ore in the north vein, which with the present incomplete exploration seems unworkable at 2100 ft. Across the Gastineau Channel the great mines at Juneau are being rapidly brought into production. At the Perseverance, of the Alaska Gold Mines, the caving system is working excellently, as much as 350 tons per machine-drill shift being obtained from one stope. It is announced that Mr. J. H. Mackenzie will take charge at the Alaska Juneau as managing director, additional assurance, if any had been needed, of the success of the enterprise.

PHILIPPINE ISLANDS.—Gold production in the Philippine Islands is increasing, and the operators there have recently formed the Philippine Mining Association, which will endeavour to bring the resources of the islands to public attention, and also to protect mining companies from too heavy taxation. A tax of $1\frac{1}{2}$% on the gross output of gold mines was recently imposed, and the operators take the position that the industry is too young to stand such a heavy impost. In the case of one of the companies, the tax amounts to $2\frac{1}{2}$% of the capital. The gold output is growing, having shown an increase of 36% in 1914. About half of the total of \$1,174,633 comes from Aroroy, in Masbate, where four mills of modern design are at work. The dredges in the Paracale-Mambulao region yielded \$500,000 in 1914 and the rest came from the Mountain province, where the Benguet district will soon increase its output, as a new 10-stamp mill has been built by the Headwaters Mining Co. A new field has recently been discovered near Iligan in Mindanao, where a conglomerate bed is reported to have yielded assays of \$3·00 to \$15·00 per ton. Early work in the Philippines was disappointing, for the prospectors looked for rich deposits that could be exploited without the expenditure of much capital. Apparently the Philippines are a good field for companies that are prepared to spend sufficient sums in exploration and development.

CANADA.—As is customary, the yearly report of the Mond Nickel Co. is concerned only with financial matters. The report now issued is the first since the re-arrangement of share capital a year ago, when the nominal value of the ordinary shares was expanded to $2\frac{1}{2}$ times their former value and each deferred share was exchanged for ten ordinary shares. The dividend on the ordinary shares for the year ended April 30 was at the rate of 20%, as compared with 35% the year before, the reduction being, of course, not real but apparent, having regard to the larger present capitalization.

SOUTH AMERICA.—The 'G' shaft at the St. John del Rey mine in Brazil has been completed to a vertical depth of 5826 ft. below outcrop, and cross-cuts are being driven toward the lode at this level (Horizon 20) and at the 5526-ft. level (Horizon 19). The orebody on Horizon 18 at 5226 ft. has developed in a most satisfactory manner. Five years ago the manager, Mr. George Chalmers, commenced the systematic study of rock temperatures at depth, with a view to ascertaining the probable temperatures to be encountered if the orebody persisted to 7000 ft. or more, and in our issues of June 1911 and June 1912 we gave accounts of his conclusions. He has this month published further information. A new system of ventilation is to be inaugurated whereby the incoming air is to be cooled and dried.

RUSSIA.—It is to be hoped that the authorities will not withhold permission for the Spassky company to raise new capital for the Atbasar property. Having in view the importance of copper in warfare, it would seem that such a point might well be strained in an effort to secure to our Allies further supplies. If the decision be adverse the Spassky has funds that can be made available for the work, though the latter cannot be pushed as vigorously as had been hoped. At the Spassky mine work on the new plant goes on rapidly, the Russian authorities having recognized its importance and returned men withdrawn in the course of mobilization. It is hoped by the end of the year to have both the flotation plant and the reverberatory furnaces at work, and so to pass from high-grade to low-grade production without diminution of output. It sounds odd to hear 7% copper ore spoken of as low-grade in these days, but the barium sulphate present affords the explanation. The new process, by obviating the heavy expense for flux, will enable copper to be made almost as cheaply from the low-grade as formerly from the high-grade ore. Incidentally, it is pleasant to record that the bottom of the mine shows better ore than for some time past, and the blast-furnaces can be kept busy for some time. At the Atbasar some 500,000 tons of ore, averaging 9% copper, have been developed by close drilling. Since of this 150,000 tons developed further by underground work proved to average more than 10% copper, well warranted confidence is felt in the results of the drill. The concentrator and reverberatories are building, and heavy pieces of machinery are being brought in along the railway line by relaying a short length of rails. The grade is completed and sleepers down, but all the rails have not been delivered, and bridge building is still incomplete. If permitted to spend the money, the company could complete the works and produce copper next year.

CHINA.—Additional regulations announced at Pekin late in May, and designed to prevent speculation in mining concessions, are so cumbersome as to limit most severely what chance remained for co-operation of foreign capital in development of new enterprises. Briefly, to secure a mining concession bond must be given either by the chairman or vice-chairman of a Chamber of Commerce or "the director or manager of a company or shop which has a capital of $30,000 or more and has been registered in the Ministry of Agriculture and Commerce." The Chamber of Commerce, company, or shop must be situated either in the native place of the representative, in the place where his business is carried on, or in the district of the mine. Despite the presence of important deposits in China, and with distinctly favourable impressions of the Chinese, we are forced to believe that development of the mineral industry will be extremely slow under such conditions.

NORWAY.—The Orkla Mining Co. is about to sink a 1100-ft. shaft near Lokkens Verk. The work is to be done on contract by E. J. Longyear & Co., of Minneapolis, and will be under the charge of Mr. L. D. Cooper, chief engineer for that firm. It will be interesting as affording a comparison of American *versus* European methods, applied under European conditions. The heavy demand for men in Great Britain and on the Continent, due to war conditions, gives this enterprising American firm an unusual opportunity. Mr. Cooper has recruited his force from among the iron miners in Michigan.

EDITORIAL

AMONG the subscribers to the War Loan the Indian gold-mining companies take a prominent place. The Mysore, Champion Reef, and Ooregum, have applied for £40,000 each, the Nundydroog £20,000, and the North Anantapur £10,000. The Ashanti Goldfields Corporation has taken £25,000, and the Rio Tinto £225,000. But these companies do not stand alone, for throughout the Empire the great mining companies are loyally supporting the Government with their surplus funds.

'EVERY path hath a puddle,' as we in our capacity as Editor are reminded, in the midst of rejoicings over the high prices of metals, by the discovery that type-metal has increased by 30%, and that the printer's brass rule has doubled in price. Zinc and copper are so high that every illustration that escapes censoring by the Managing Director may well be considered important indeed.

THE devious ways of certain types of city promoter are exemplified by the case of the Tough Oakes Gold Mines, Limited. This company was promoted last year by Mr. H. G. Latilla, of Rhodesian fame, to acquire through a parent company, the Kirkland Lake Proprietary, 426,388 shares of $5 each in a Canadian company bearing the same name, Tough Oakes Gold Mines, Ltd. Readers will recall our criticisms of February 1914. Events have justified the doubts we then expressed of the extravagant flotation of what we believe is an excellent though as yet not large property. The sale of 200,000 shares brought the English company the sum of £200,000, of which £44,996 was paid to the Kirkland Lake Proprietary for 66,781 shares in the Canadian Tough-Oakes and £30,253 for Kirkland Lake Proprietary shares. Out of the balance £112,831 was advanced on loan to other companies controlled by Mr. Latilla, on the security of various shares. These shares were quoted on the Stock Exchange at the time the loans were granted, but on the outbreak of war their market disappeared. Thus the money advanced by the English Tough Oakes Company is irrecoverable, at least at the present time. Action has been taken in the courts by holders of subscribed shares with the object of obtaining a compulsory winding-up of the company. This action is suspended owing to lawsuits in another court. The sale of the Tough Oakes property in England has been badly muddled.

MINING engineers are as a rule a nomadic tribe, and their activities are continuously being transferred from one place to another. In Australia the record for persistence of management is held by Mr. Richard Hamilton, who has been manager of the Great Boulder mine at Kalgoorlie since the start in 1894. That he has the confidence and esteem of his fellow engineers and of the financial controllers of the mining companies is evidenced by the fact that he has recently been re-elected for the eighteenth time to the presidency of the West Australian Chamber of Mines. But even his record for long service is exceeded by that of Mr. George Chalmers, who has been manager of the St. John del Rey company's gold mine in Brazil since its re-opening in 1888.

ESTABLISHMENT of tin smelting in the United States is under consideration by a number of different interests. Our San Francisco contemporary, the *Mining and Scientific Press*, in its issues of September 26 and November 21, announced attempts made last autumn to transfer to North America a part of the European smelting industry founded on Bolivian tin. These came to nothing, but the situation is still being studied. One of the most important British companies has had under consideration a project for establishing a branch smelter in the United States, but no definite action has as yet been taken. In the meantime, word comes from New York that the American Smelting and Refining Company has entered the industry, and proposes to erect a tin smelter near that city. Mr. Willard Morse, for many years the manager at Aguas Calientes, in Mexico, is in charge of the new venture.

ESTIMATES of the probable deficiency of spelter in Great Britain for the present year are subject to much uncertainty, but in the trade the present feeling is that 60,000 tons more than is now in sight must be found or saved from consumption. One complication is that furnaces in the United Kingdom are only running at a capacity equal to 35,000 as against normally 55,000 to 60,000 tons per year.

ENLISTMENT of men from the technical staffs of various mining enterprises naturally imposes burdens on those that remain. These are, however, so much less than those borne by the men who go to the front that they should be assumed without question. In most instances there has been no cause for complaint on this score, but we regret to learn that the manager for a firm operating extensively in the Malay tin fields interposed many difficulties in the way of at least one young engineer who, having had military training, wished to return and place his services at the disposal of the Government. We cannot believe that the action of this manager would have the approval of the firm itself, and at any rate it is so exceptional as to stand out by contrast.

MEXICO, true to her *manana* spirit, still postpones the time of peace. There has again been fighting in the City, though details are lacking. Rival chiefs each announce 'glorious victories,' followed, alas, by strategic retreats, but in the meantime the number dependent upon the Red Cross for daily bread grows appallingly. The death of Diaz in Paris calls sharply to mind the contrast between the peaceful prosperous Mexico he ruled and the Mexico of today. Diaz was one of the great men of his time, a genuine patriot who loved his country and his people. It is a great pity he did not inspire all his followers with equal patriotism. Many an unworthy grandee grew rich and insolent under his shadow, but Diaz died a poor and honoured man. It has become common with a certain section of the press to blame Diaz for the latter days of Mexico. Let us rather blame conditions. The Mexican people were travelling the road of social progress. They had too much education to be content where they were, and too little to move at once into democracy. In the crisis the strong man who had guided them had not the force to hold back the 'plunderbund' that is present in all nations, and disaster came. It is the fault of even the most benevolent despotism that it breeds weak subjects. The world is indeed 'a scene of changes,' for Huerta and Orozco are said to have been plotting together, and have come into conflict with the authorities of the United States, in which country they now reside. How much longer the American Government will wait before taking up its obvious burden is still uncertain. In the meanwhile all is chaos. The new crop is estimated only at 25% of the normal. Mexican credit is gone, and Mexican money has become a joke. The larger mines have issued *vales*, which we illustrate, for

labour and supplies, and these are generally accepted at considerable distances. They even stand at a premium of as much as two to one over paper money issued by various Mexican authorities. It is interesting to record that similar paper notes issued by provinces and communes constitute the principal circulating medium in Belgium at present.

AMID the din of war, with its unparalleled requirements of metal, the report of the Home Office committee on the use of white lead and other lead compounds in painting operations has been overlooked. The official report of the evidence taken, and of the conclusions based upon it, is of great technical interest. The recommendations amount virtually to proposing the abolishment of white lead as a basis for paints. As zinc white is the only practicable substitute, it is obvious that nothing can be done at the present time, seeing that zinc is scarce, and urgently required by the makers of munitions. One paragraph in the committee's report will be read sympathetically by the ordinary householder, who has to exist the best way he can during the time the painters are in possession. In framing this paragraph, the committee went outside the limits of the official reference, and urged that, when the authorities were considering serious legislation, they should also take into account the poisonous effects of the mediums in which the pigments are incorporated, that is to say, the linseed oil and turpentine. To the average man, the gaseous emanation of newly-made paint appears to be more poisonous than its mineral constituent, and he will therefore welcome the committee's suggestion that the scope of the investigations should be widened in this way.

Estimating Ore Reserves.

How to value untested ore reserves is an ever present problem. Obviously the exact realizable value is not known until the bullion is produced or the concentrate sold, though experience indicates that the value of blocks of ground properly developed and adequately sampled may be closely approximated. The difficulty is with blocks only partly developed. Mr. D. T. Morton, manager for West Rand Consolidated Mines, after recording 1,453,000 tons of "fully developed payable" worth 6·05 dwt. over 49 inches, and 340,000 tons of "partly developed payable" estimated at 7 dwt. per ton, notes 412,000 tons of "fully and partly developed ore (for which a definite value cannot at present be given, but which is expected to yield a considerable proportion of payable ore.)" This conveys a useful idea as to the extent of the orebody, but does not commit the management to a valuation that may not be realized. Somewhat similar methods are used by other Rand managers, and the same problem arises in other parts of the world. For example, when Mr. J. H. Mackenzie was at the Goldfields Consolidated in Nevada, he always stated the reserve in tons, wisely refusing, with that erratic ore, to fix a value. At the Associated Gold Mines at Kalgoorlie, caution has been exercised ever since 1909, when the returns for milling operations were much below the calculated assay-value of the reserve. Mr. D. F. McAulay, who became manager after that episode, confines his figures relating to reserve to the tonnage. At the group of gold mines in India, managed by John Taylor & Sons, the rule has always been to quote tonnage only, with the added note that the average content may be taken at not less than that of the ore currently treated. A question might be raised as to why a definite value cannot be assigned to any block of ground that is "fully" developed, as part, at least, of the ground estimated by Mr. Morton evidently is. It is the business of the engineer to form a definite opinion when the facts are available, and the purpose of fully developing ore is to value it. However, there are many blocks of developed ground which cannot be profitably extracted, regardless of their intrinsic value, because of isolated position or mining problems, unless neighbouring blocks prove also rich enough to mine. Presumably it is such ore that Mr. Morton has in mind. At Cobalt the problem of valuing ore-reserves is especially difficult because of the small size and richness of the veins. A slight increase in tonnage may mean a large increase in value. There are here situations in which the engineer meets the reverse of the usual difficulty in which he must affix a value to an indefinite extension in depth. In such mines as the Crown Reserve, Cobalt Lake, and others underlying the lakes at Cobalt, it is the extension upward that must be measured. Every presumption favours the continuity of the ore from the highest working level to the bottom of the lake, but it is obviously impossible to place such ore 'in sight' in advance of draining the latter. In the report of the Canadian Mining Corporation just issued, Mr. D'Arcy Weatherbe has preferred to employ the conventional methods of valuation, thereby decreasing materially previous estimates of the amount of ore in the Lake property. This is conservative and happens to be unimportant, as the particular property is not being valued for sale, but it does not answer the technical question involved. As the water has now been drawn off, it will be interesting to learn just how much could have been allowed for the 'backs' of which only the bottom edge exposed in the stope-face could be sampled.

The Zinc Corporation as a Lead Producer.

The name by no means always indicates the main business of a company, and for the present this is true of the Zinc Corporation Limited. Formed in 1905 to treat zinc tailing at Broken Hill, it has become an important lead producer, and is now able to pay its preference dividend from the profits of lead mining, thus meeting a difficult situation. In 1911, it will be remembered, the Corporation absorbed the Broken Hill South Blocks. The zinc lode in this mine is now being developed, though not yet mined. The lead lode, while it yields some zinc, is mainly valuable for the lead-silver content. It is this which constitutes a source of revenue for the Corporation now that the sale of zinc concentrate is temporarily suspended by war. The new policy of depending on two metals rather than one has been abundantly vindicated. It is impossible to separate entirely the lead business of the company from that of treating zinc tailing and selling zinc concentrate. Nevertheless, the annual report recently issued permits the segregation of certain items of interest.

Up to August the mills operated as usual. After that only lead ore from the South Blocks was treated. The total lead production for the year was 21,836 tons, of which 17,162 tons came from the lead mill. The actual output from the mine was 141,667 tons of ore containing 14·8% lead, 2·4 oz. silver, and 9·3% zinc. This yielded 26,567 tons of lead concentrate dressed to 64·60% lead, 9·20 oz. silver and 6·45% zinc, and a further 34,317 tons of zinc middling containing 4·9% lead, 1·6 oz. silver, and 15·8% zinc. The gross value of the lead ore based upon recovery figures out at about £2. 19s. per ton and the working cost is given as 16s. 1·17d. It is worth noting that the Zinc Corporation treats the lowest grade ore and has the lowest working cost in the district. The cost quoted is that chargeable to the tonnage from the mine, which has been credited with 5s. per ton for the zinc middling, sent from the lead mill to the zinc concentrator, that being the average cost of such material from other sources. The reserves in the mine are stated at 1,185,870 tons assaying 14·8% lead, 2·4 oz. silver, and 9·3% zinc. The net financial result of the year was a profit, after allowing for depreciation, of £129,398, of which £49,138 was paid in dividends. It may be noted that the Corporation has not heretofore been engaged in smelting, but has recently arranged to join with its neighbours in an enlargement of the Port Pirie works at which it is planned to treat all Broken Hill lead ore. Though this move is forced by war conditions, it is fundamentally sound in itself. The joint smelting and sale of the lead output of the district, amounting to about 200,000 tons per year, will give the Broken Hill producers a deservedly important position in the lead markets of the world. The Zinc Corporation will pay, out of profit and without additional financing, £100,000 for its part in the new enterprise.

Incomplete as these figures necessarily are, they indicate that the Zinc Corporation is already a more important factor in lead production than is often recognized. In itself, and through its relations to the Burma Corporation, it may well become of even more consequence in the future as the zinc tailing that formed its original basis is exhausted and greater dependence is placed on lead mining. It is interesting to compare its lead business with that of the Bunker Hill & Sullivan Mining & Concentrating Company, the principal independent producer in the Cœur d'Alene district of Idaho. This is exclusively a lead-silver producer and its output is naturally larger than the lead business alone of the Zinc Corporation. Reducing all figures to British weights and measures, the Bunker Hill & Sullivan produced, in 1914, 31,591 tons of lead from

393,530 tons of ore assaying 10·35% lead and 3·80 oz. silver. The tonnage of concentrate was 55,059, and the grade 67·90% lead, with 20·68 oz. silver. The total cost, excluding smelting charges, was 10s. 5d., to be set against a gross value of the crude ore of £3. 6s. 1d. The net profit after depreciation was £236,169, and the dividend £204,375. The Idaho ore is poorer in lead than is that mined by the Zinc Corporation, but sufficiently richer in silver to more than recompense. Both ores are dressed to about the same percentage of lead. The total tonnage handled at the Bunker Hill is larger than that of the lead ore alone of the Zinc Corporation, but if to the latter be added the zinc tailing treated, the total, 363,287 tons, compares favourably with that which went to the mills, 393,530, at Kellogg. For reasons already given it is impossible to make exact comparisons of cost, though these seem to favour the Bunker Hill. Wages are not greatly different, but the Broken Hill mines face a heavy charge for water and coal. In the Cœur d'Alene, hydro-electric power is available. Also the greater complexity of the Broken Hill ore makes re-treatment necessary. Of the total difference in profit for the year, £73,152 is accounted for by the larger scale of operations and higher grade of the ore at the Idaho mine. The latter also has larger developed ore reserves, 3,708,271 tons containing 10·35% and 3·8 oz. silver, but this is to be offset by the zinc tailing remaining to be treated by the Zinc Corporation. At both mines there are large blocks of ground still to be explored, and it is a coincidence that in the South Blocks mine, workings extend 1399 ft. below the surface, and at the Bunker Hill 1400 ft. below the main adit; the latter though happens to be 600 ft. below the old open-cuts at the surface. Both mines are great enterprises, honourable examples of mining at its best.

Caving Methods of Mining.

Following the description of the 'Diamond Fields of German South-West Africa' by Mr. Charles W. Boise, which appeared in our issue for June, we present this month a careful review of the development of 'Mining Methods at Kimberley' by Mr. Gardner F. Williams, the engineer whose technical knowledge so ably supplemented the financial genius of Cecil Rhodes in the development of the South African diamond industry. In Mr. Williams' well known book, 'Diamond Mines of South Africa,' the whole story has been told. This particular chapter relating to the methods of underground mining and how they were developed, was the basis of a scholarly address delivered before Section D of the American Association for the Advancement of Science at Philadelphia last December. It brings the subject down to date and with the revision he has given and the additional illustrations supplied, will, we are sure, prove of much interest to our readers.

The significance of the article from a technical point of view is that it tells the story of the development of one of the most important systems of 'caving,' a method now widely used for mining large orebodies. Mr. Williams went to Kimberley in 1887 and found in operation a room and pillar system of mining in which caving was avoided rather than encouraged. Acting on a suggestion made by one of his workmen familiar with longwall work in coal mines, he turned about face and introduced the principle of planning for a caved roof; winning, in fact, as much as possible of the blue ground by utilizing gravity, and meeting nature rather than opposing it. At that time caving was by no means as common as now, and the step was revolutionary. In applying the method to thick orebodies, as contrasted with thin coal beds where longwall mining, a phase of caving, had long been known, many modifications were found necessary, and the work done at Kimberley has greatly influenced the general development of caving methods. It was not, however, the first application. Caving methods in all probability all go back everywhere to longwall work, though there is the difference that in caving proper the roof is completely broken and comes down as a mass of loose material, while in longwall it is preserved and bends down over the whole area rather than breaking into particles. It was in the coal mines that extensive underground mining was first done along horizontal planes. Early coal mining began as pillar and stall work. As depth was attained and conditions became favourable, longwall mining methods were developed, though just where and when seems uncertain. Metal miners were still mainly mining large orebodies by open-cut, or operating on thin beds lying at high angles. In such situations there was neither the need for nor the possibility of using the method developed in coal mines. It was probably in the irregular orebodies of the Lancashire hematite mines that the first caving system was developed. It was a logical evolution from the chamber work in the old lead mines, notably the Van mine in Wales, and it showed curious likeness in some phases to the later Kimberley method, though we believe the latter to have come independently. In the iron mines, the points of attack were short drifts driven to the wall from rises. At the wall itself a 'face' closely similar to that in longwall work was opened and the ore was won by 'top slicing' retreating to the rise. In time a natural development was the caving of part of the ore over each slice. This method was introduced in America in 1883, when, according to D. H. Bacon, Mr. G. W. Wallace, superintendent at the Cleveland hematite mine, put it into operation. Mr. Wallace, as in the case of Mr. Williams, received the suggestion from a workman. The method proved so well adapted to iron mining in the Lake Superior region that it was quickly and widely adopted throughout that region, and at the same time adapted to so many different conditions that there is now a bewildering number of caving systems in the United States and many claimants for the honour of the discovery. By 1890, however, it was widely known. It was but a few years later that the Lake Superior engineers and men began to interest themselves in copper mining in the western states and with them went the caving system. All the big 'porphyry' mines not suitable for open-cut work are now worked by some form of caving, and without the method the ores could probably not be mined. An excellent account of the method as now used at the Ray mines was given by Mr. L. A. Blackner in the June *Bulletin* of the American Institute of Mining Engineers.

In other countries than Africa and America the system has as yet been little used, though Mr. G. D. Delprat in 1891 described a system used at the Cabeza del Pasto copper mine in Southern Spain employing the principle. At the Mansfeld copper mine in Germany a true longwall method is in use, and in the far east Rand plans have long been made for introducing a similar system of work. So far it has not been done, and one familiar with the skill needed in bringing down the roof in longwall work in coal mines, is quite prepared to believe that the engineer who succeeds in adapting the method to any Rand gold mine, will have a notable technical achievement to his credit. Caving proper is, naturally, out of question on the Rand owing to the thinness of the orebody.

This brief review brings out the fact, too often forgotten, that it is impossible to divide mining into separate branches according to the material mined, and to stow each into a separate air-tight compartment; whether it be diamonds, coal, iron, gold, or copper that is won, it is all excavating of rock. The engineers in each branch have much to learn from their fellows, and it is not well to leave the transmission of knowledge from mine to mine too exclusively to tramp workmen, much as a plague is spread by rats travelling through sewers from house to house. The wise manager regards suggestions from his men, but it is better still to pour into a common reservoir the knowledge each acquires in the course of his day's work.

Substitutes for Spelter.

When the price of beef goes up many men buy mutton or pork. The result is a decrease in the demand for beef, and an increase in that for other meats, until an approximation to the old ratio of prices is automatically re-established. The same phenomenon may be widely observed. The rapidity with which price ratios swing back to balance depends upon the extent and speed with which substitutes can be found and employed for the material first in demand. From the middle of May to the middle of June, to go back no farther, the price of spelter increased 120%. The excess demand was for war purposes. As we pointed out last month, lead is now little used in warfare, either as compared with former times or with other metals. Still lead rose 43% in price in the same two months and has since gone higher. The reason lies in the practice of substitution, and relief from the present exceptional prices for spelter lies in the further possibilities of that art. In normal times, approximately half the spelter made is used for galvanizing. Now these trades are at a standstill and spelter is not being bought for such use in any large quantities. For a time the galvanizers, working on accumulated stocks or buying under old contracts, disregarded the higher price, but already the stoppage of works is important both in Great Britain and the United States, the two principal producing countries. Galvanized sheets increased in price from 10 to 60% in two months, and many consumers have suddenly remembered that for certain uses sheets and wire that are painted are as good, and even in some situations better than the galvanized. There is also the possibility of substitution of entirely different materials, such as tarred felt for roofing, or the reversion to use of sheets of puddled iron which show high resistance to rust without any coating. The purpose of galvanizing is to protect the steel from corrosion. Coating it with another metal reduces its strength slightly, since a thin layer of the steel itself alloys with the coating metal, but over this alloy is a layer of pure metal or non-ferrous alloy which is oxidized in lieu of the steel. The same purpose is served when blocks or strips of zinc are put in boilers to protect the inner surface from corrosion. Zinc is the favourite metal for such use, but others may be used. Tin is excellent for coating and, except for price, would be used commonly, despite the greater labour and more complex process involved in spreading it on steel. Tin is the only metal that can be used when the resulting sheets are for making food containers. An alloy of tin and lead, in the proportions of 3 to 7, is employed in making 'terne' sheets, which are available for roofing and indeed for all the common purposes for which galvanized iron is sold. Until recently, owing to difficulties in the methods of manufacture, it was not feasible to make terne plates larger than 20 by 28 inches. These difficulties have been overcome and from plants as widely apart as Wales and Ohio, standard sizes and gauges are now offered. The terne mixture, with lead at £27 and tin at £165, costs £67 per ton. Allowing an unusually heavy coating, the cost figures to 0·65d. per square foot, at which price terne competes on equal basis, so far as metal is concerned, with the usual spelter coating at £65 per ton. Actually the cost will be higher, at least until large scale work reduces the expense of manufacture. Lead coated plates are also available, since lead can be laid on steel sheets previously tinned or dipped in vats of hydrochloric acid in which tin and zinc have been dissolved. Such sheets have commanded little attention up to now. The skin of lead must be thicker than that of zinc, but at prices for spelter much lower than those now obtaining there is economy in the use of lead and there is a wide field for such sheets. It seems certain that one result of the present upheaval in metal prices will be a permanent conquest by lead of part of the field previously held by zinc. In the future a smaller difference in the prices of the two metals may be expected.

The second big use of spelter is in the making of brass. There are so many varieties of this and it is used for such varied purposes that the possibilities of substitution are endless. Brasses are alloys of copper and zinc, but a wide range of other metals are known to form alloys and slight changes in composition produce marked changes in the properties of the resulting alloy. Zinc is added to copper to raise its tensile strength and to increase its elongation. This is especially important in such work as drawing cartridge shells from discs. But the same properties can be given to copper by alloying with aluminium, forming aluminium bronze. It reaches its practical maximum of usefulness in this direction at about 7% of aluminium. It is also possible to decrease the amount of spelter needed in ordinary brass by substituting small amounts of aluminium. Thus an alloy containing 60% copper, 38% zinc, and 2% aluminium has the same properties as one containing 45% zinc. Broadly 1% of aluminium is equal to 3½% of zinc in brass. The aluminium bronzes have not been as largely used as their qualities warrant. Professor H. C. H. Carpenter, of the Royal School of Mines, has done notable work upon them, and with rare generosity he has offered to advise gratuitously manufacturers who wish to substitute them for brass, a substitution which, at present prices, is both feasible and profitable. This is one way to meet the industrial and munition difficulties created by the war, and we are glad to record that here, as in many other lines, the members of the mining and metallurgical profession are 'doing their bit.'

Dangers that Beset Explorers.

The absence of new discoveries of surface deposits or of bonanzas, and the decline in the world's output of gold, have combined to give the impression that the earth's surface has been fully explored. Not only so, but it is often supposed that the risks and dangers from hostile races have vanished from the explorer's or prospector's course, and that the white man's presence is everywhere tolerated or even welcomed. But many countries remain to be explored and the spice of danger still exists. Opposition to the white man is not nowadays on so large a scale as it used to be. Less than a hundred years ago the westward course of empire was bitterly opposed by the North American Indian, and the colonization of Australia and New Zealand was checked by the Maori and by the wielder of the boomerang. Within the last generation, the battles-royal between the white races and the Zulu and Matabele have stirred the imagination, and the pacification of these turbulent tribes has added glory to the white rule. The adventures of today seem small in comparison, but they are none the less real.

That danger has not entirely disappeared is evidenced by the diary of the chief of a prospecting party sent out by the Société Internationale Forestière et Minière du Congo, a Belgian company in which American capital is interested. This company has its head office at Brussels, but the force of circumstances has made it necessary to move the administration to London. The part of the Congo State investigated by this expedition is in the neighbourhood of the upper waters of the Kasai river, a tributary of the Congo, joining the latter a hundred miles north of Leopoldville. The village of Tshikapa, at the junction of the Lovua river with the Kasai, and not far from the Portuguese frontier of Angola, was the headquarters of the expedition. On July 24 of last year the party left Tshikapa, escorted by Lieutenant Heide, with 50 soldiers, and proceeded southwest to the village of Tshiselale, on the Lovua. It was at this village that an exploring party including Newport and Decker were camped the year before when ambushed, and here that Decker was killed. At this village, Sub-Lieutenant Colinet, with 49 soldiers, awaited the arrival of the present expedition. The following day, the party commenced the journey south to the boundary of Angola, then west to the Lushiko. Travelling was extremely slow and difficult, as the entire caravan had to wait while prospecting was done on the small streams crossed on the route. It was necessary to travel in a closed caravan, to guard against an attack by natives and also not to permit the natives to catch a small party alone. As it was, the natives attempted several times to discourage further advance, and succeeded in killing one soldier near the village of Kapandu. The party found remnants of Newport and Decker's belongings in every village south and west of Tshiselale. One native that was shot was found to be wearing the knife and fork holder of Decker's canteen as a cartridge belt, and a woman was captured who was wearing one of Decker's shirts. The natives had sent the women, children, and live-stock into Angola to the village of Kalinda, only the warriors remaining. These followed the party continually, in hopes of waylaying a detachment, or catching them unprepared for an attack. The natives were finally reinforced by warriors from the surrounding country, and then felt that they stood a good chance of annihilating the party by making a general attack. They made four such attempts in one day, but Lieutenant Heide routed their forces, and the expedition proceeded. The party cannot say too much in praise of the Lieutenant, for it is entirely due to him that the caravan arrived safely, with the loss of only the one soldier. Lieutenant Heide always endeavoured to pacify the natives, sometimes at great personal danger, advancing alone to meet an armed band, in hopes of convincing them that it was to their advantage to lay down their arms. He did everything within his power to aid in the reconnaissance, and to make the trip easy, and also as enjoyable as possible under the conditions. He was ably assisted by Sub-Lieutenant Colinet, and the State officials at Kandala and Katchi-na-Katchi always gave their aid. After arriving at Shamalenge, the party proceeded to Kandala, then south along the west bank of the Kwilu to the Gufu rapids, returning to Shamalenge on September 21. The next morning they left for the mouth of the Lushiko, escorted by Lieutenant Heide and 25 soldiers, where one week was spent prospecting in that vicinity, returning to Shamalenge on September 29. On the next day they left Shamalenge for Tshikapa Post by way of the Rupendi country, thus completing a journey occupying two months and a half, replete with adventure.

About the same time in a far distant region, the bush in the Northern Territory of Australia, an engineer examining the tin gravels in the Roper River district was facing difficulties and danger though, fortunately, there were no actual conflicts with natives. The gravels in question are characteristic of the eastern part of the Territory and of the northern peninsula of Queensland, and on the western side bordering on the Victoria river and behind Port Darwin, attempts have been made for many years to develop a gold-mining industry. This area was also examined by the engineer mentioned. In several parts of the Northern region the surface is covered with a great variety of grasses suitable for cattle and sheep, and as the climate, though hot, is not too damp, efforts have been made by the Government to establish a grazing industry. But no sufficiently important mineral discovery has been made, such as would induce a large influx of pioneers, and as it is only by mining 'rushes' that a local demand for agricultural supplies can be established, all the Government efforts at settlement have been in vain. Consequently, the aborigines have been little disturbed since their country was discovered by Captain Cook. They have continually exhibited hostility, and though not openly offensive nowadays, care has to be exercised so that surreptitious attacks may be prevented. The first white settlement in the Territory was at Fort Dundas on Melville Island, where a military post was established in 1827. This had to be abandoned owing to continual conflict with the natives, and other depots were temporarily maintained at Raffles Bay, Essington, and elsewhere, all to share the same fate as Dundas. Stuart crossed the continent northward in 1862, and shortly afterward a telegraph line was constructed along his route, connecting Adelaide with Port Darwin. In 1868 Port Darwin was finally made the political and business centre of the Northern Territory. Subsequently a proposal for building a railway was mooted. The line so far constructed extends from Port Darwin southward for 150 miles, and from Port Augusta on Spencer Gulf northward to Oodnadatta. The Federal Government is now seriously considering the construction of the connecting link. When this is completed, the agricultural resources of the North will have a chance of development, and at the same time some systematic policy will have to be devised for dealing with the aborigines. It is estimated that they number from twenty to thirty thousand. Some of the men can be taught labourer's duties, such as tending herds of horses or cattle, and the women occasionally are employed as cooks or servants. Their intelligence is low, and when they are forced to forsake their " native nothingness " and don the clothes required to satisfy the white race's idea of decency, they rapidly become the victims of consumption. It is, at present, proposed to make Melville Island a reserve for them and to remove them entirely from the mainland. Our friend who supplies us with these details from the spot gives picturesque accounts of their habits and customs. They have no hut or home, but sleep wherever they happen to wander. When used at all, the loin-cloth or the apron is at the irreducible minimum, and a buck considers himself arrayed in full dress when he wears an old striped pyjama jacket. Their diet consists of insects, snakes, and yams, with occasionally a kangaroo. Their weapons are chiefly long spears, and straight sticks are used for throwing. The degree of civilization, or rather of the absence of hostility to the white man, varies considerably. Some of the natives have been taught to be friendly, but many are covertly hostile. Our pioneer has suffered no attack in his wanderings, but he has a shrewd idea when it is not good to be alone with the black, and has so far escaped any untoward adventure.

These two instances remind us of the dangers incurred when prospecting in countries where the native knows little of the white man. The expression 'uncivilized countries' is hardly available just at this time when the European nations are locked in a murderous death-grapple, and while the pioneer of liberty in the Western Hemisphere refrains from interfering to prevent assassination and anarchy in the republic to the south.

Origin of Malay Tin.

Kinta geology has become a field for controversy, and the great tin-yielding valley in the Malay States seems destined to become as famous for its contributions to science as to metals. It will be recalled that some three years ago Mr. J. B. Scrivenor, the Government geologist, propounded a most interesting theory to the effect that the Gopeng beds, in which much of the tin occurs, were of glacial origin and to be correlated with the Gondwana series of India. In our issue of May 1913 we printed a map and an abstract presenting Mr. Scrivenor's views, and in the following issue commented upon them. Mr. Scrivenor's interpretation was new and revolutionary. Accepting it, much light was thrown upon the probable distribution of the tin and the rules to be followed in prospecting. It has not, however, found complete acceptance, and in a paper presented to the London Geological Society on June 23, Mr. W. R. Jones has marshalled strong evidence against the glacial theory. Brushing aside the absence of striæ on the underlying bedrock and of striated boulders in the beds in question, Mr. Jones presents definite evidence as to the origin of the beds through ordinary agencies and offers a simple, in place of a complex, explanation of the phenomena.

The Kinta valley is flanked by high granite ranges. The granite is of Cretaceous age and intrusive into the sedimentary series which floors the valley. This series includes Carboniferous limestone, certain phyllites and schists, and the disturbed clay beds in question. Over all are patches of modern alluvium. The limestone occurs as bedrock and as cliffs along the edge of the valley. Mr. Scrivenor considered the cliffs to be upraised masses due to block faulting. Mr. Jones considers their aspect the normal result of intense weathering of jointed rock. He traces the soft clays into the harder phyllite and schist and refers the change to the effect of thermal waters incident to the intrusion of the granite and to weathering agencies. The harder quartz, being less soluble, has been broken into angular masses mistaken for boulders, and the whole mass has been given an abnormal and disturbed appearance as a result of slumping during the alteration and dropping of material into pot-holes and solution channels in the surface of the underlying limestone. Apparently here, as has often happened, underground solution has been particularly active along the surface between the limestone and the overlying phyllite, now the reputed boulder clay. Mr. Jones has traced tin-bearing veins step by step from the unaltered phyllite into the soft clay, and has even, with the assistance of a mine manager, found veins in the unaltered rock by cross-cutting from jumbled masses of tin ore in the clay. He points out further that 90% of the tin has been found within a mile of the granite, and that the flats in the middle of the valley are agricultural rather than mining, except as they are covered with recent alluvium. If the source of the tin be a true boulder clay there would be no reason for such distribution. Since the granite is an adequate source, and for much of the tin the admitted source, it is unnecessary to appeal to such a chain of coincidences as is involved in the assumption of an older unknown tin-bearing area traversed by glaciers that transported material to the exact spot where much later a new impregnation of similar tin should take place. Mr. Jones presents convincing argument for a much simpler explanation, and proves again, as Professor W. W. Watts said, "that the marvellous is not necessarily true."

MINING METHODS AT KIMBERLEY

By GARDNER F. WILLIAMS.

From primitive digging of small pits to mines from which 180,000 tons per month is hoisted from one shaft, is a long leap. Mr. Williams tells how the many difficulties were overcome. The methods of mining and hoisting are described, and the development of caving, now an important system of mining, is related in detail.

DIAMOND mining at Kimberley began in the form of pit digging on individual claims. By a regulation of the Orange Free State, official roadways were reserved between the pits, but an ever present danger hung over the miners from the very outset of their work in the diamond-bearing funnels. The yellow ground was a breccia so loose and friable that it was constantly caving-in upon the heads of the diggers. Moreover, the pits were sunk so close together that the walls gave way and slipped, crumbling into the claims below. A loaded cart, passing along the edge of a road, would often topple over and sometimes plunge with driver and mule into the pit below. The diggings at Dutoitspan, Bultfontein, De Beers, and Kimberley were ardently opened by swarms of diamond seekers. The surface area covered by claims was much larger than the diamond-yielding ground, the total extent of which was, approximately, seventy acres.

EARLY METHODS.—The method of mining, with the reservation of roadways determined by the government inspectors, proved a poor makeshift at best, before sinking had progressed many feet below the surface. The bordering claim owners undercut the roadways crossing the mine in working to the bounds of their allotments, and these reserved roads soon began to cave away in places to an extent that made the passage of carts very risky. It was doubtless convenient to have ready access to every part of the surface of the mine, but it was a burlesque on mining. It was continued until no possible patching or bridging could preserve the roads.

At the end of 1872 the mine was an open, oval quarry, about 1000 ft. in length and 600 ft. in extreme width. The broken blue ground on the face of the rough jumble of terraces had been hoisted to the surface usually in buckets, by means of a rope passing around a windlass and through a pulley fixed in a pole set near the edge of the claim ; but in 1872 a simple device of haulage over two grooved wheels was largely introduced. One wheel was set on the pit bottom, and the other on

EARLY WORKINGS AT KIMBERLEY. "THE RESERVED ROADS SOON BEGAN TO CAVE AWAY IN PLACES TO AN EXTENT THAT MADE THE PASSAGE OF CARTS VERY RISKY . . . IT WAS A BURLESQUE ON MINING."

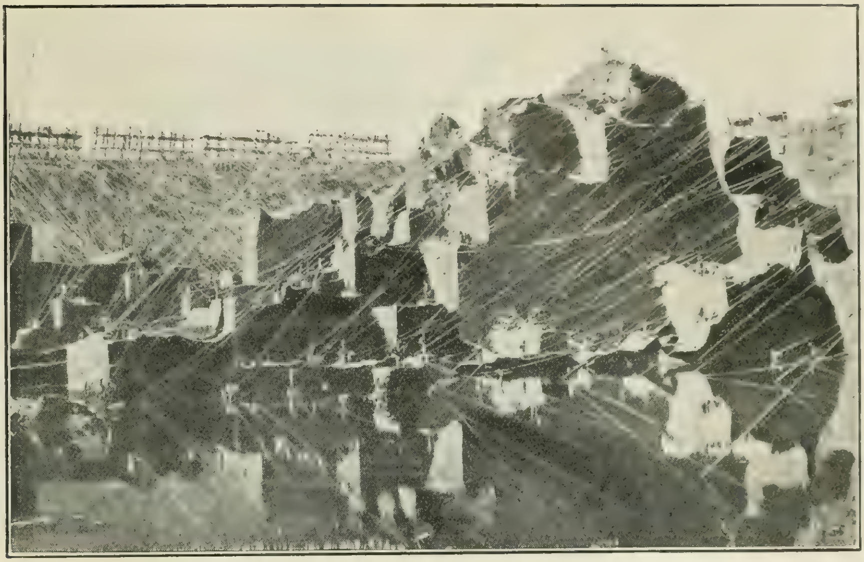
the surface, with a handle attached, by means of which one or more stout natives could wind up a rope passing from wheel to wheel, carrying up a loaded bucket and lowering an empty one. This crude device served the purpose as long as a wheel could be set near the edge of a claim of unbroken ground. It was followed by an extensive development of overhead wire-rope haulage from pit to staging at the edge. The lines came to be so closely set that the whole pit seemed to be covered with a monstrous cobweb. Hand hoisting gave way first to horse whims and then to steam, but the whole system eventually failed because of the difficulty and expense of handling water and removing waste rock due to crumbling of the walls of the crater. In 1874 a mining board was organized with power to levy assessments to meet this expense. This board fought vigorously a losing fight. In 1878-79, the French and Central companies undertook the removal of solid rock on an extensive scale, sinking shafts several hundred feet north and south of the edge of the pit, and also building inclined tramways on the west and the east to cut back the upper walls, but these efforts were too late, and in 1883, the mining board being bankrupt, the work stopped, and by many the Kimberley diamond mine was believed to be doomed.

The open pit had been sunk to the depth of something over 400 ft. in the lowest working at the end of the year 1882. In order to haul out 1,000,000 loads of blue ground during that year, 3,000,000 loads of 'reef' had been raised. The cost of hauling was increasing with the deepening of the mine, and owing to the reef falls, the production of diamonds was disastrously sinking. In 1883 the lack of funds only permitted the lifting of 1,500,000 loads of reef at a cost of £250,000, and the output of blue ground sunk to 350,000 loads. In November of that year a long portended reef slide cast 250,000 cu. yd. of shale upon the face of the pit, piling its mass on the claims half across the mine. This was conclusive proof that open-pit sinking was no longer feasible, even for the richest claimholders. About 4,000,000 cu. yd. of reef had been hauled at a cost of nearly £2,000,000, yet there was no check to the falls and slides. At the close of the year the Inspector of Mines reported that "only about fifty claims had been regularly worked during the past year." The chances for the operation of individual claim-holders were decisively closed. The only hope for the mine was in the prosecution of deep and extensive underground works by the combination of claims in hands able to conduct such operations successfully.

TEMPORARY MEASURES.—In advance of such an undertaking the yield of the mine was fortunately sustained by an expert makeshift. Edward Jones sank a shaft through the mass of fallen reef at the bottom of the deepest part of the mine by lowering a square timber frame and shovelling out the loose rock from the inside of the enclosure. The frame was constructed in sections on the plan of a coffer dam, adding section to section from the top until a stout timber shaft passed entirely through the broken shale and entered the underlying blue ground. The shaft was then readily extended, and drifts from this opening were made through the blue ground. The peculiar service of this device was its saving of hundreds of feet of costly shaft cutting through the solid reef to reach the blue ground, a very desirable contribution at a time when the richest claim-holders were sharply pinched by the failing mine and the discouragement of capital. The cost of all development work was defrayed by the blue ground extracted in opening the drifts and cross-cuts, so that there was no further delay in resuming operations in the mine. The first shaft had been sunk on the ground owned by the Central company, and it was soon copied by a number of similar shafts in other parts of the mine. This brought about a most welcome revival of mining, and was highly beneficial to the labourers, claim owners, and towns-people of Kimberley, though it was not designed for permanent service.

While the blue ground was being removed through shafts sunk in the bottom of the open mine, it was apparent to all that the life of these shafts must be short. Preparation was therefore made for future work by sinking shafts outside the margin of the open mine, and at sufficient distance from it to insure them against any probable caving of the surface ground in their vicinity. Vertical shafts were sunk by the Central and French companies, and tunnels driven from them.

SYSTEMATIC MINING.—At the end of the year 1885, although the need of amalgamation of claims was obvious and imperative, there were still 98 separate holdings in the four mines. Prior to the consolidation of the holdings in De Beers and Kimberley mines, the underground workings were prosecuted with the general design of withstanding pressure and sliding of the reef by leaving sufficient solid blue ground, in the form of 'floors' or



MINING BY MEANS OF OVERHEAD WIRE TROLLEYS. "THE WHOLE PIT SEEMED TO BE COVERED WITH A MONSTROUS COBWEB . . . THE SYSTEM EVENTUALLY FAILED BECAUSE OF THE DIFFICULTY AND EXPENSE OF HANDLING WATER AND REMOVING WASTE."

'roofs,' between the series of levels, supported by buttresses and pillars of blue ground. Costly experience by frequent collapses of the roofs and crushing of the pillars proved that the levels were too near one another, and that galleries driven full size from the offsets were difficult to maintain and unsafe for the workmen.

The heavy expense of sinking vertical shafts and driving through the hard rock surrounding the mine had led to the adoption of inclined shafts in order to reach the blue ground more quickly; but, for several reasons, these inclines were not adapted for the prosecution of deep underground works. They were difficult to maintain, as they were sunk obliquely through the horizontal strata of the shale, which frequently gave way and crushed the shaft timbers. Secondly, being inclined to the horizon (De Beers 56°, and Kimberley Standard shaft 32°) and situated not far from the margins of the mines, they soon reached blue ground, and were continued down in this breccia, which must sooner or later be mined.

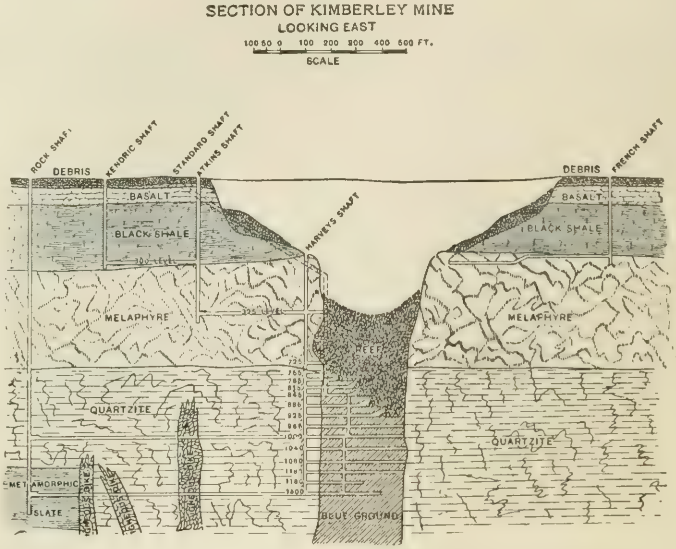
GOULDIE SYSTEM.—When I took charge of De Beers mine, in the year 1887, it was worked under what was then known as the Gouldie system. It was similar to the method of mining the iron ore in the hematite mines of Cumberland, England. At this mine an inclined shaft had been sunk to the 500-ft. level, with intermediate levels 30 feet apart between the 380-ft. and 500-ft. levels. Drifts were driven across the crater at De Beers mine from west to east, about 120 ft. apart, and rooms 18 ft. wide and 18 ft. high were opened every 36 ft. along the main drifts, and were worked up to within 12 ft. of the loose ground in the top levels. Pillars of solid blue ground 18 ft. thick were left between the galleries, but later on first the roof and then the pillars were taken out.

This method of mining was fairly successful for a time; but as depth was attained, the roofs of the galleries became unsafe before they were opened through to those on the next level above, and they frequently gave way, thus making the extraction of the blue ground exceedingly difficult. This system was both expensive and dangerous. No timber was used except in the main drifts, the nature of the blue ground being such that the roofs and sides of the excavations stood fairly well for a short time, provided they were well ventilated.

INTRODUCTION OF CAVING.—A general system of mining was needed and was devised and applied shortly after my appointment as general manager of the newly formed De Beers Consolidated Mines Ltd. Instead of attempting to withstand, even for a time, the pressure of the superincumbent mass of broken reef, the new system contemplated the caving in and filling of the excavations, after the precious blue ground had been extracted.

In order to make the output of diamond-bearing ground as great as possible, the levels in De Beers mine were at first opened up in the new system according to the following plan:

When the numerous small galleries had been driven to the margin of the mine, that is to the point where they reached the sides of the crater, the blue ground was stoped on both sides of and above each drift until a chamber was formed extending along the face of the rock for 100 or more feet, with an average width of about 20 ft., and height of 20. The roof of the chamber or gallery was then blasted down or allowed to break down by the pressure of the overlying mass of broken diamond-bearing ground or debris. I mention diamond-bearing ground here, for in the early stages of underground mining there was an enormous amount of this which had been left behind when open mining was discontinued, and which had been crushed either by the moving sides of the immense opening or by the collapse of the underground pillars when mined by the old system. It happened frequently, after breaking through to the loose ground above, that clean diamond-bearing ground would run down as fast as it was removed for weeks or months at a time. The galleries would at times become blocked with large pieces of blue ground, which had to be blasted, and then a further run of blue ground would follow. When the blue ground was worked back toward the centre of the crater, larger boulders or fragments of basalt, which had come down through the loose reef from the surface, would be met. This system of working was continued until reef alone came down, the waste or reef removed being sent to the surface by itself and dumped on the reef tips; it formed, however, only an inconsiderable proportion (one to four per cent) of the total output. It will be remembered that, when the roof caved in, the gallery was nearly full of blue ground. By the work which followed, only a part of this ground was removed by the men working on that level, the miners preferring to take out on the next level below. This process of mining was repeated from level to level until finally there was no more loose ground to be recovered. The cost of extracting blue ground while loose ground existed was very low. Now all this has changed, and the plan of opening up new levels has altered somewhat; the system has changed even considerably since I retired from the management.



Cross-section showing geology and workings illustrating the method of drawing off the 'reef' (broken rock) and blue ground while working under cover.

The levels were opened around the east end of the mine. When the underground works had reached a depth of 800 ft. or more, a new danger appeared. It will be borne in mind that the huge open mines are filled with debris from the sides, caused by the removal of the diamond-bearing ground by open quarrying to depths varying from 200 to 500 ft. As the supports were removed, the sides caved and filled the open mine. This debris was composed of the surface red soil, decomposed basalt, and friable shale, which extended from the surface down to a depth of about 300 ft. In addition to the debris from the surrounding rocks there were huge masses of 'floating shale,' resembling indurated blue clay more than shale. Large heaps of yellow ground and tailing, which the early diggers deposited near the margin of the mines, and the poor west-end yellow ground contributed to the mud-making material. The black shale which surrounds the mines disintegrates rapidly when it falls into them. It contains a small percentage of carbonaceous matter, and a large amount of iron pyrite. When these huge masses of shale fell into the open mine, they frequently ignited, either by friction or, more probably, by spontaneous combustion, as they have been known to do on the reef tips, and burned for months and even for years at a time. These masses of burned shale became soft clay and formed a part of the mixture which fills the open crater. This debris moved down as the blue ground was mined from underneath it, and became mixed with water which flowed into the open mine from the surrounding rock and formed mud. This overlying mud became a menace and danger to the men working in the levels below. Frequent mud rushes occurred suddenly, without the least warning, and filled up hundreds of feet of drifts in a few minutes, the workmen being sometimes caught in the moving mass. It became evident that the method of working then in use was dangerous in case a mud rush took place, the men being sometimes either shut in or buried in the mud coming from the opposite side of the mine. I decided, therefore, to adopt the suggestion of the miners themselves, to work the mines from one side only, and to have the offsets to the rock connected one with the other at as few points as would still allow the ventilation of the working faces.

METHOD OF UNDERGROUND MINING.—Main drifts are driven across the crater upon its longer axis, and, at right angles to this, smaller drifts are driven out every $22\frac{1}{2}$ ft. until they reach the hard rock on the side of the mine. These drifts are widened, first along the rock until they connect one with another, and, at the same time, the roofs, or 'backs,' are stoped up until they are within a few feet of the loose ground above, thus forming long galleries, partly filled with blue ground, upon which the men stand when drilling holes in the backs. The working levels are 40 ft. apart vertically. The broken blue ground lying in the galleries is taken out, as a rule, before there are any signs of the roof giving way. At times this is impossible, and the roofs cave upon the broken ground, and the blue ground is covered with reef. As the roofs cave or are blasted down, the blue ground is removed, and the loose reef lying above it comes down and fills the gallery. Drifts are often driven through this loose reef, and the blue ground, which has been cut off and buried by debris, is taken out; but it is often left for those working the next level below to extract.

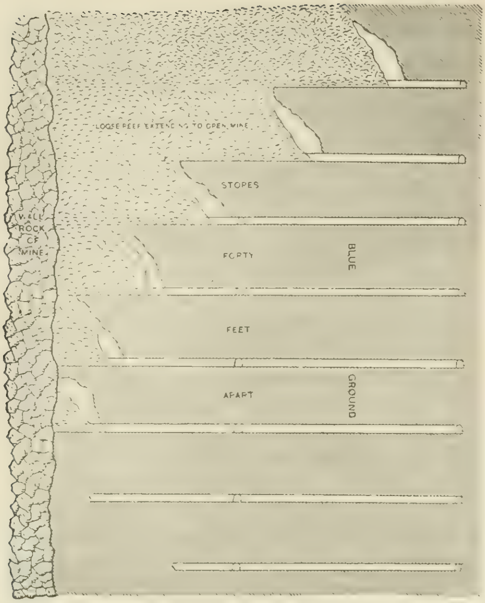
After the first cut near the rock is worked out, another cut is made, and in this manner the various levels are worked back, the upper level in advance of the one below, forming terraces. The galleries are not supported in any way by timbers, but all drifts in soft blue ground are timbered with sets of two props and a cap of round timber, and where necessary are covered with inch and a half lagging.

Soft blue ground is drilled with long jumper drills sharpened at both ends. In hard blue ground short drills and single hand hammers are used. The native workers become very skilful in both methods of drilling.

INCLINE SYSTEM.—A change in the method of stoping has been adopted during the past few years and is known as the incline system. This is a modification of the back pillar method as used at Kimberley mine and differs from that only in the shape of the roof. In the old system the roof was carried up level over the length of the chamber with solid ground on all four sides. With the incline system the roof is inclined along the length of the chamber as shown on page 26. The plan of the level and the end sections of the chamber are also shown.

As in the old system the pillars between the cross-cuts are blasted out to a height of from 8 to 9 ft. and from 18 to 20 ft. wide, except when next to the country rock, when the chamber is only 8 ft. wide on account of the treacherous nature of the ground at the contact. The back pillar is left as in the old system so as to hold back the waste ground. Pole-ways are put in at every third off-set as formerly, and are used for means of escape and ventilation purposes. The chamber is first opened out for five blocks, or about 112 ft. long. One end of the chamber is raised up until the roof has an incline of 23 to 28°. The roof is kept on this angle by drilling and blasting until the next level is reached at the high end. Sufficient ground is loaded out each shift through the cross-cuts to allow room for drilling. When the high end is through to the next level, another block at the low end is blasted out, and the chamber kept the same length, about 5 blocks long or 112 ft., and the roof at the same inclination.

As the chamber is broken through to the level above at the high end, successive blocks are broken out at the low end, and the chamber continued until the low end reaches the country rock, or a chamber at right angles, when the low end is carried up squarely as in the old system. When a long chamber can be planned, say 600 to 800 ft. long, the pillars are blasted out in the centre and for 5 blocks in each direction, the centre of the chamber



VERTICAL SECTION OF STOPES IN THE DE BEERS MINE.

being the high end and the retreating is carried on in each direction.

There are numerous advantages with the incline system. The low end of the chamber furnishes an additional and better means of escape than the pole-ways, and also allows for better supervision of the native labour. It is also safer to enter after a blast, as the roof can be inspected as the men go up the incline, whereas under the old system no inspection of the roof could be made until the top of the pole-ways was reached. Holes are placed to better advantage with the incline system and better returns are made per case of explosive. Loading from the high end can be started as soon as the chamber is finished at that point. With the old system the whole chamber had to be finished before loading could be started.

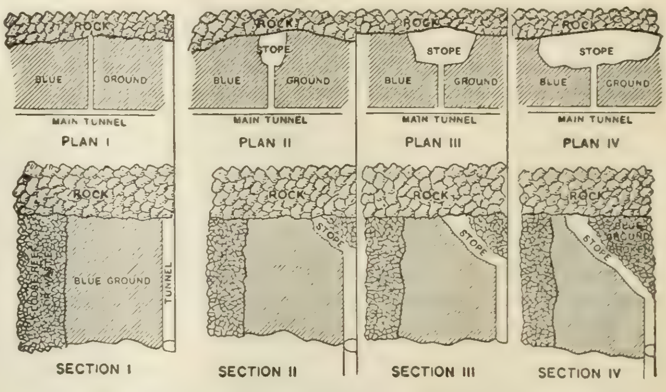
Care has to be taken that the incline of the chamber is not too steep, as any ground falling at the high end would roll down the pile and crush the drillers lower down in the chamber; otherwise the same precautions taken with the old system apply to the incline system.

The pillars on the level are drilled with hand labour, but the overhead stoping is now carried on entirely with Waugh stoping drills, which are peculiarly adapted to this nature of the work. Before the Waugh drills were adopted, between 20 and 30 drill boys (Kaffirs) worked each shift in a chamber drilling from 40 to 60 five-foot holes. Or in other words a Kaffir drills an average of 10 ft. in a shift of 8 hours and with the Waugh drill from 60 to 80 ft. With the Waugh drills the same number of holes are drilled at half the cost of hand labour.

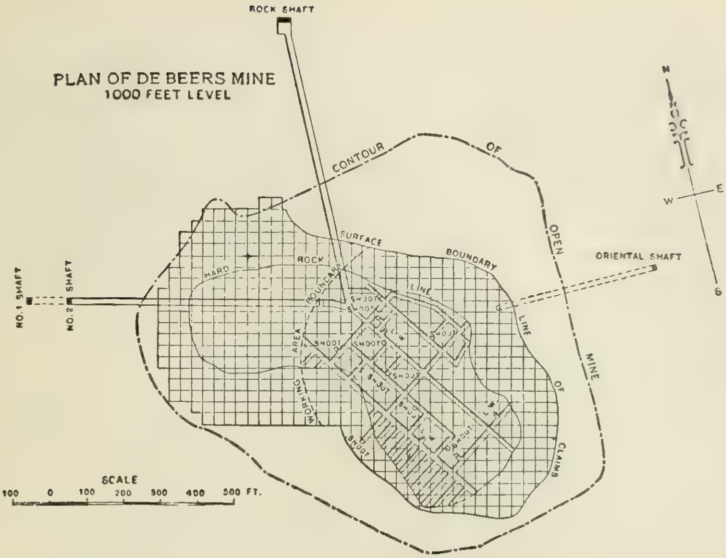
TRAMMING AND HOISTING. — The blue ground, when removed from the chambers, is tipped into passes to the tramming level. At this level it is again loaded into trucks and sent to the shaft by mechanical rope haulages at all De Beers mines except Dutoitspan, where electric locomotives are used. At the bottom of the shaft the blue ground is tipped into chutes with a capacity just equal to one skip load.

The blue ground is then hoisted through the shaft in skips and dumped automatically into bins at the surface. All hoisting through the main shaft is done from the lowest level, the blue ground from the upper levels being dropped through passes to this level.

At Kimberley mine the rock shaft is connected with the mine on the 1000, 1200, 1520, 1840, 2160, 2520, and 3520-ft. levels. Trucks holding 16 cu. ft. transport the blue ground in the mines from the loading place to the main shoots or passes, and from these to the shaft. Side tipping trucks holding 20 cu. ft. are in use. The trucks are hauled by an endless wire rope which rests upon clips fastened to the trucks, the power being supplied by engines driven by motors. At the shaft there is a large station cut out of the solid rock, some 30 ft. wide, and extending back toward the mine for a distance of 70 ft. to a point



DE BEERS METHOD OF OPENING STOPES AT POINTS OF CONTACT OF DRIFTS AND WALL-ROCK.

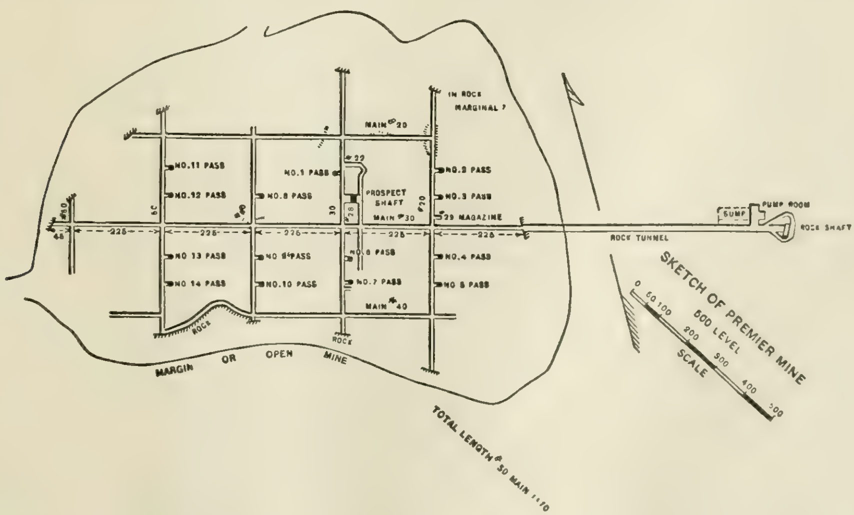


PLAN OF WORKING FROM ONE SIDE ONLY AND MAKING AS FEW CONTACTS WITH THE WALL AS IS POSSIBLE, STILL MAINTAINING VENTILATION.

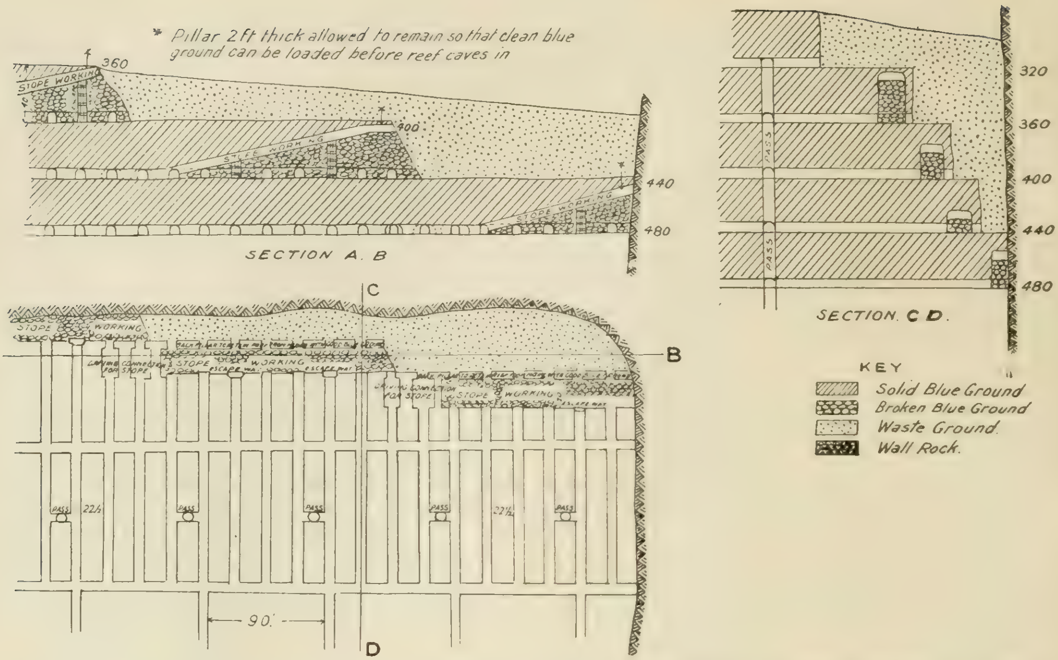
where the drift (8 by 11 ft.) commences. There is an extension on one end of the shaft for a small cage-way to bring up any ground that may spill over the skips while being loaded. This prevents delays in the skip hoisting. The shaft is also lengthened for a few feet at the pump stations.

Those who have travelled through the native centres, or have seen the negroes loitering about the towns, and have thought them lazy, indolent, beer-drinking beings, should visit the diamond mines, and especially the scene upon the 'flat sheet,' and they will get a new impression of the working capacity of these despised black men. The natives working in the diamond mines, if they are old hands in the service, are uniformly active and industrious men, while natives fresh from the kraals are soon taught their duties, which they learn to perform with nearly as much skill as most European miners

No more rapid handling and extraction of



METHOD OF WORKING FROM ONE SIDE WITH LIMITED CONTACT WITH WALL-ROCK, AS DEVELOPED AT THE PREMIER MINE.



CAVING METHODS AT THE DUTOITSPAN MINE ILLUSTRATING MOST RECENT DEVELOPMENTS OF THE INCLINE SYSTEM.

the blue ground seems possible than is effected by the aid of these alert workers and the perfected mechanical devices. As soon as the loaded trucks reach the shaft, they are tipped into loading shoots holding ten or eleven tons. As the skip reaches the bottom a door is opened, and the contents of the chute run into the skip and are hoisted to the surface. Experience has shown that the best results are obtained by sending up loaded skips from one level at a time.

The time of the journey through the shaft varies only a little with depth, being from 35 to 40 seconds from the 1200 or 1520-ft. levels. On reaching the surface, the blue ground is tipped automatically from the skips into loading boxes. The self-dumping skips in present use were introduced in 1888, but have been greatly improved. From the chutes the blue ground is loaded into side-tipping trucks holding 20 cu. ft. each. The average weight of the blue ground in a surface truck is 2000 lb. The trucks used underground in the intermediate levels where the ground is dumped into passes hold 16 cu. ft. From the depositing surface boxes at the winding shafts, the ground is taken by means of an endless wire rope haulage to the 'floors' where it is treated.

At the Kimberley mine, the main or rock shaft was started on the north side of the mine in March 1889. In the first year this shaft was sunk to the depth of 699 ft., and, in the following year it was pushed to the depth of nearly 1300 ft. For hoisting at this shaft, a winding-engine plant was especially designed by the late Louis I. Seymour, mechanical engineer for De Beers Consolidated Mines Ltd., and constructed in England. This plant consisted of a pair of vertical tandem compound engines driving two reels. These engines were designed to hoist six truck-loads in one skip, from the 1000-ft. level, in 45 seconds, including filling, starting, stopping, and discharging; but in practice the engine hoisted this load from the 1000-ft. level in from 30 to 35 seconds. Flat ropes were used, at first, on the reels, but when the shaft was sunk some hundreds of feet deeper, round ropes were substituted by the adoption of the Whiting system, first used by S. B. Whiting, general manager for the Calumet and Hecla Copper Co. of Michigan.

The average cost per load for flat ropes was 0·6 of a penny, 1·2 cents, against 0·076 of a penny, 0·15 of a cent, with the present Whiting system, the saving amounting to more than £2000 per annum. This system as modified in the diamond mines is as follows: The round winding rope, made of the best plough steel, extends from the skip over the sheave on the pit-head frame down to the reel on the crank shaft of the engine, thence four times around this reel and a corresponding reel on a lay shaft (centres of shafts being 12 ft. apart); thence the rope passes around an idler sheave, the shaft of which runs on bearings set upon a movable frame, which is attached at each end to a carriage by means of trunnions. The carriage in this case runs upon a track 50 ft. long. From the idler or tension sheave the rope passes around a second sheave which is loose upon the crank shaft, the centre of which is in line with the second sheave upon the pit-head frame.

The problem of handling large quantities of ground from the De Beers mine had my careful attention when general manager for the company and has been studied in detail by my son and successor, Alpheus F. Williams, who has written on the subject in the *Journal* of the South African Institution of Engineers.*

The reader may be referred to that article for details, but the table below may be quoted to illustrate the efficiency of the system of concentration of effort adopted.

Mine	Depth of hoisting	Capacity skip	Capacity skip	Highest output in 12 hr.	Actual time	Highest no. skips per hr.	Highest weekly output	Highest monthly output
	ft.	cu. ft.	tons	tons	hr. min.		tons	tons
Wesselton....	980	210	11	8286	10:35	86	42,374	180,437
Bultfontein...	1000	165	8	7256	10:42	94	41,080	167,949
Dutoitspan...	750	210	11	8873	10:2	91	46,680	193,778

DRAINAGE.—Thorough drainage is of manifest importance in the operation of any mine, but it is peculiarly essential in these diamond mines. At the commencement of underground mining the inflowing water was removed by steam pumps. The use of such pumps was an error, for the resultant heat and moisture caused the blue ground to crumble, and made the ladderways so hot that they were at times almost impassable.

As soon as the vertical shafts were completed at De Beers and Kimberley mines, Cornish pumping plants were put in, by the means of which all the water was pumped from the mines. The average quantity of water taken from De Beers mine was 4350 gal. per hour, and from Kimberley, 8385 gal. Nearly half of the latter comes from a crevice at the junction of the quartzite with an intrusive dike of igneous rock which was found while driving the 1200-ft. cross-cut at a distance of 600 ft. from the mine. While no water is found in the blue ground or mine itself, that which flows into the mine from the surrounding rock mixes, as before described, with the debris which has fallen into the worked-out portion of the De Beers and Kimberley mines, and makes mud. Enormous quantities of this mixture are from time to time forced suddenly into the working parts of the mine.

At Kimberley mine, large springs of water flowed into the open works at the junction of the melaphyre with the shale or 300 ft. below the surface. Only a small part of the melaphyre was then exposed to view, and the position of the other part was unknown. One gallery was driven to the south around the mine; another was driven to the west end around the mine in the opposite direction until the two met. The total length was 2097 ft. Through these all the surface water and all water coming into the mine above the melaphyre was taken up and led to the pumps by means of pipes. All water which enters the mine in the deeper workings is taken down in passes, sunk in the rock outside of the mine.

De Beers mine was not so fortunate, and mud rushes were of frequent occurrence, although the quantity of water in the mine was only about one-half that of the Kimberley. After several years and the expenditure of large sums of money, the danger was in a great measure removed.

The pumping plants for freeing the mines from water have kept pace fully with the advance in the hoisting plants. For the service of De Beers mine, a new pumping engine was erected at the rock shaft in 1889. This was a compound surface-condensing engine. With this engine an average of nearly 6000 gal. per hour was readily drained from the mine from the start, and no difficulty was experienced in lifting over 8000 gal. per hour at times. The cost of pumping is largely offset by using the water drained from the mine for washing the pulverized blue ground. For the Kimberley mine a Cornish pumping plant of 400 h.p., from designs by the late L. I. Seymour, was erected in 1891. This is a vertical triple-expansion condensing engine, with cylinders $15\frac{1}{2}$, $23\frac{1}{4}$, and 37 inches in diameter, and a stroke of 36 inches. The gears for this engine were made in America, and the shafts were of Whitworth steel, but the main constructors were James Simpson & Co. Ltd., of London. With this plant an average of over 12,000 gal. per day was readily pumped from the mine, and there has been no further difficulty in handling the influx of water into the workings.

*'The Kimberley System of Hauling Large Quantities of Ground in the Minimum of Time.'—*Journal South African Institution of Engineers.* Vol. IX, 1910-11, pp. 156, 174, 192.

PROSPECTING IN THE EASTERN TROPICS

By GILMOUR E. BROWN.

Hints to travellers in eastern countries such as the Malay Peninsula and the East Indies, with notes on the character of labour available, and of local mining and prospecting methods. An excellent shaft-sinking record is quoted.

NOT many years have elapsed since the search for mineral deposits, in unopened countries, was left in the hands of experienced prospectors, invariably pioneers of the old school with only a rudimentary knowledge of types of ore deposits, counterbalanced, however, to some extent, by an eye trained in 'spotting a winner.' With the 'winners' eliminated, estimation of the chances of those 'who also ran' proved more difficult, and recourse was had to a fuller and more detailed consideration of their 'points.' To weigh the data in their proper light requires a good knowledge of mining and economic geology, so that it is becoming more common to find mineral exploration under the supervision of a mining engineer, who, if not by training, is at heart a geologist. It is from that view-point that the following notes are written, not only to interest readers of *The Mining Magazine*, but to prevent a further addition to that waste of experience, which, the Editor says, is the greatest waste of all.

Prospecting trips and mine examinations, extending over several years, in Burma, in the majority of the Native and Federated States of the Malay Peninsula now conveniently grouped under the name of Malaya, and in Sumatra, Java, and Borneo, have afforded experience for a general review.

It is absolutely necessary, of course, that a man who intends going alone out of touch with civilization, have a constitution above the average, and also a knowledge of how to avoid or combat the more frequent maladies. Malaria, although rarely deadly in attack, claims many victims by undermining constitutions, and demands constant protective measures. In an article, written several years ago, in the *Mining and Scientific Press*, there appeared a statement to the effect that the malaria-carrying mosquito bites only after sunset, to which I would add 'except when

MAP SHOWING THE MALAY PENINSULA AND THE EAST INDIES.

In Southeast Borneo the Malays are expert shaft-sinkers and are employed for testing alluvial ground.

disturbed in his haunts in the daytime.'

The greater part of the prospecting work in the tropical Far East consists in valuing alluvium, tin-bearing mostly in Malaya, and gold-bearing in the Dutch East Indies. Under existing laws there is little inducement to search for tin in the Dutch possessions.

The alluvial ground is generally swampy, and when permanently so, is covered with a dense growth of a soft-stemmed plant, resembling sugar-cane, growing to a height of over 8 ft. and holding few mosquitoes. When the swamp is alternately wet and dry for long periods, due to floods or change of seasons, it contains substantial timber with a fairly thick thorny undergrowth, and is infested with mosquitoes. Drilling in such swamps is trying in the extreme and necessitates building smoky fires around the drill, creating an atmosphere which the mosquitoes, at least, find unbearable. It is often necessary, for convenience of work and of water, to camp close to the swamp, so that when the sun goes down, life seems, as Kipling says, to "warrant writing with a big L."

In addition to the usual camp-bed mosquito-net, it is desirable to have a high mosquito-net of a suitable size for a double bed, and place the camp table and chair, or their substitutes, inside it. A tent makes a poor residence in the tropics, but is occasionally useful. For a short stay on a concession, which is all virgin jungle, a convenient size is that used by the Federated Malay States Government surveyors, namely, 16 by 14 ft.; 'A' shaped, with a fly one-foot clear of the tent, and 3 to 4 feet longer than it. Wherever possible a floor should be constructed, 2 to 3 feet from the ground, and the tent raised accordingly. The floor is usually of split bamboo, thin saplings or wide sheets of bark, and a canvas sampling-cloth on top of it prevents the upward flight of mosquitoes.

Scorpions are plentiful in Malaya, and love to dwell under boxes or in boots resting on the ground. Snakes, during the dry weather, have a hankering for the inside of an abode, and, although the majority are harmless, a rude shock to your feelings can be avoided by sprinkling sand around or by completely encircling the hut or tent with a hair rope. These precautions, however, are rarely taken.

The Malays are expert at rapidly erecting a jungle-hut with the materials at hand, and it saves time as well as conducing to comfort, when moving about a large concession, to send Malays in advance to build huts at convenient centres. A small hut and shelter for 6 coolies cost 17 shillings in the State of Kelantan, while a substantial camp, good for one year, in Borneo, consisting of a large hut, 30 by 15ft. and a 3-roomed hut 18 by 15 ft., the latter with a sawn-plank floor, cost together £21.

In the Federated Malay States, where the Chinese coolies have overrun the country, it is customary to employ them as carriers for short excursions to the outskirts of the mining districts, but when a long journey is contemplated Malays are necessary. Chinese carriers will spend an hour re-arranging your chattels to their entire satisfaction and that of nearly every idle coolie in the village, shouting advice freely to each other all the time, but once under way each will carry 100 lb., sometimes considerably more, at a pace over 3 miles an hour, for 20 miles without a murmur. Malays, on the other hand, require constant humouring, cajoling or threatening, in order to induce them to carry each a load of 30 to 60 lb. three-fourths of the distance in twice the time. In some parts they make surprisingly good carriers, their willingness depending largely on their financial state.

In the northern states of the Malay peninsula, it may be possible to hire elephants for the transport of baggage from waterways to the foot of the mountains. These are rarely equipped for passengers, and after a few hours, perched on top like a stranded mariner on a rock, walking seems a delightful exercise. I paid 10 shillings for a day's hire of two elephants in Kelantan. On the east coast of Sumatra and Borneo, in particular, a journey of several days' duration in a dug-out is generally necessary to reach the foot-hills beyond the extensive coastal plain.

The Malay language, shorn of many of its beauties, is the medium of intercourse between Europeans, Chinese, and Malays, and with only a few local variations, holds good from Burma to Timor. In the Dutch colonies the teaching of romanized Malay is more advanced than in the Federated Malay States, and it is easy to secure prospectors there, almost of the coolie class, who can describe intelligently in writing the places from which their samples were taken.

Europeans, who know the habits of Malays, refrain from drinking water, except when taken from a well and boiled. To drink water from a stream, when travelling, is to risk typhoid, dysentery, and cholera. Water boiled overnight and carried in a large thermos flask is useful on a march, but the milk from coconuts pulled before the husk has begun to yellow, is preferable. Just a little brandy poured into a green coconut makes a cool, pleasant, effervescent drink.

Streams form the highways in virgin jungle, affording at the same time good rock-exposures and opportunities for testing. Wading up and down such streams, crossing and re-crossing to avoid patches of thick thorny undergrowth, is the quickest mode of progress and the only one likely to yield results in a short time. In tall timbered virgin jungle the sun rarely penetrates, the gloom and damp being depressing to a degree. The spirits of even jungle-hardened Malays have to be maintained, and a clearing should be made for the camp. If big game abounds there, the small hill leeches will form a terrible pest, necessitating constant watchfulness to make sure that they do not crawl higher than the tops of putties.

The engineer owes it to his employer not to take more risks with regard to big game than are necessary for the work, but a little relaxation is often desirable, if not advisable. Good sport, training for big game, and fresh meat, can be had with wild pig and deer, although occasionally a boar makes no mean antagonist. The Malayan tiger is particularly numerous in the south of the peninsula, and in Sumatra. The natives are by no means whole heartedly in favour of their extermination. They fear the breeding propensities of the wild pig with regard to their crops. It is not advisable to wander about alone in the jungle, even within a short distance of the camp, although there is little danger if constantly in motion. Stooping over a stream to wash a pan of gravel may afford the opportunity for which a tiger has been waiting, but even a tiny fire will scare him. The Malays, who travel through the jungle gathering rattans, always go in pairs. In the north of the State of Johore, it was a daily occurrence while camping in the jungle, notorious for tiger, to be paced by one about 50 yards away, easily heard but completely hidden by the thick undergrowth. Waiting for a shot or a rush to get one brought no more satisfaction than the finding of his tracks.

A useful light weapon is the 0·401 automatic Winchester with soft-nosed bullets. Its stopping power is barely sufficient, but it has a great advantage in rapidity of fire without moving the hands.

Elephants are plentiful but difficult to approach without exercising great caution as to direction of wind. On one occasion I found myself unarmed, during a downpour of rain, within 20 yards of a solitary wild elephant, which was investigating some old mine-buildings. The closing of a large Japanese paper umbrella, prior to flight, proved beyond his understanding and he bolted headlong into the jungle.

The actual searching for tin in Malaya is done by Chinese, more rarely by Malays. Both are 'grubstaked' by Europeans, but more often by wealthy Chinese, resident in the coastal towns or mining centres. The expense of maintaining several Chinese for prospecting around the outskirts of a mining camp is small compared with that of maintaining a European in the field with all the servants and impedimenta necessary to his health and comfort. In the Dutch colonies the Chinese are neither allowed to roam about at will, nor to apply for or take-up mining land. The Chinese invariably work their finds themselves except in places of difficult transport or lacking water. They work the shallow ground and then proceed to offer the deeper ground to Europeans, as suitable for dredging, usually at a prohibitive figure. The Chinese are not skilled in opening lode mines and these are often offered under option to Europeans. On the west coast of Sumatra, which is one of the few vein-mining centres, the Malays have become skilful miners and are employed under white supervision for extensive prospecting operations.

In deciding whether it would be advantageous to acquire an option on land, covering part of the alluvium of a stream or river, it is often possible to form an estimate of its value from a close study of the course and nature of the channel, together with the results obtained upstream. On the other hand, the frequent occurrences in Malaya of tin in soil on hill sides and in shallow flat valleys, due commonly to concentration by soil creep from a sparse dissemination in granite, are baffling at the first introduction and an estimate of the value from the appearance of the surface would be a suitable problem for a 'clairvoyant.' Pitting or drilling is necessary, preferably pitting, if the conditions are favourable.

Where there is no water, Chinese shafts, 3 ft. in diameter, give excellent sections and samples. The Chinese can sink these shafts to depths of 30 ft. or more with a wonderfully uniform diameter, using only a home-made hand windlass, a basket, and a small hoe. For depths of 20 to 30 ft. they cost 6 to 8 pence per foot.

Malays and Tamils have an inherited disinclination to put forth all their strength when

IN SINKING A PROSPECTING SHAFT, THE MALAYS USE RATTAN LAGGING POLES BACKED WITH LONG COARSE GRASS. THE EARTH IS HOISTED IN BASKETS MADE OF RATTAN STRIP.

required, so that the physically superior Chinese have a monopoly of the hard work of hand-drilling. They are wonderful workers, when on contract, and although the soil and 'semi-alluvium' of the small valleys containing tin does not present the difficulties encountered in drilling through the pebbly alluvium of a river, their results are noteworthy.

The following are examples: Six Chinese, with a 4-in. drill and casing, drilled 3 holes daily between 6 a.m. and 2 p.m., the material being a compact sandy clay, carrying only a few pebbles, and having a soft granite bedrock at a depth varying from 25 to 36 ft. The tripod rig (with 4 poles) was used, and carried bodily from hole to hole, which were only 66 ft. apart. The cost of drilling was 7 pence per foot, and the men, knowing that they had a 'soft' contract, were out to make money. Again, 9 Chinese using a similar drill, but with the platform instead of the tripod, drilled fine alluvium lying on an irrregular limestone bedrock, 40 to 60 ft. below the surface, at the rate of 2 holes per day. In both instances, the material from the sand pumps was measured in a small box by the Malay present, but not in the contract, stored in bags, and washed at the end of the day. The drills were of local manufacture without any time-saving threads on the rods and casing.

When the holes are spaced several hundred feet apart, the platform type of drill is the more convenient, but with close spacing of holes the tripod gives faster work, provided that a track sufficiently wide to allow of it being carried as a whole, from hole to hole, can be readily and cheaply cut.

In southeast Borneo, using among other makes an Empire, in valuing alluvium 18 to 40 ft. in depth, in a wet mosquito-infested swamp, holes 200 to 600 ft. apart, my labour costs, with the Empire employing 9 Chinese coolies at 16 pence per day of 9½ hours drilling, lay between 5 pence and 6 pence per foot. In order to keep close track of the value of the respective layers, a contract was deemed inadvisable.

The same bed of alluvium was tested later, during the dry season, by sinking shafts at regular intervals of 100 ft., along lines 600 ft. apart. The work was done by a gang of 14 to 18 local Malays, living in their homes 3 to 4 miles away. In that district the washing of soil and alluvium for diamonds has been carried on for generations, developing a race of expert shaft-sinkers.

When the contract was arranged after several days' palaver, they disappeared jungleward, returning the third day with 5 sets of roughly squared timber, each piece 5½ ft. long, 30 saplings 20 ft. in length for lagging, all of specially tough timber, good, with ordinary luck, for 6 months' work. A bundle of rattans, 12 or more tiny rattan baskets, the same number of kerosene tins cut and fitted with handles, with 4 short crowbars, completed the outfit. Soft-wood sets and lagging, used when the shaft had reached a depth over 20 ft., were cut in the swamp as required.

The shafts were rapidly sunk, four men wielding the crowbars and passing up the material in the little baskets to two men standing on each set all the way up. The sets were spaced 4½ ft. apart, hung by rattans from each other and from the collar-set. The lagging-poles, outside the sets, were driven down as the shaft advanced, and packed behind with long coarse grass. The crew could easily handle 30 gallons of water per minute, and on one occasion kept twice that quantity in check for a few hours.

The contract price for a shaft 5 ft. 9 in. square was 16 pence per foot down to 20 ft., 24 pence from 20 to 25 ft., and 32 pence per foot from 25 to 30 ft., beyond which no money would induce them to go, in that heavy ground. They made each 14 pence per day in the shallow ground, 10 pence per day in the deeper ground; 8 pence per day being the labourer's hire in that district.

On the completion of a shaft, they took out as many of the lower soft-wood sets as they could, untied the rattans supporting the hardwood sets, and fixed a single rattan to each piece of every set, bringing all the ends to the surface. When the shaft filled with water, they knocked down the sets quickly, one by one, pulling them by means of the rattans to the surface. If the shaft collapsed before the upper two or three sets were out, they generally managed to save them. They then proceeded to withdraw the lagging poles, now bunched in the centre of the shaft, using a strong rattan as rope, a cross spar and a stick as a capstan. They were only beaten by water, quicksand, or dangerous ground in 8 out of 50 shafts, and lost 2 sets and 10 lagging-poles. As smart shaft-sinking this is worthy of being placed on record.

The Calumet & Hecla produced during 1914, 23,969 long tons of copper from 2,592,462 short tons of ore, being an extraction of 20·7 lb. per short ton as compared with 22·11 lb. in the previous year. The cost per pound was 11⅓ cents and the average price received 14 c.

GOLD MINING IN CHILE

By E. DAVID POPE.

Chile is best known among mining men for its copper, but there are numerous mines and prospects that point to development of an important gold mining industry. Climatic and labour conditions are favourable. The Las Vacas company, with a modern mill and good equipment, is proving the possibilities of gold mining in this country, and conducting a profitable business.

MINING for gold is a neglected branch of the mining industry of Chile, and the resources of the country in this respect are greatly underrated. In this article I have endeavoured to give a brief description of the coastal goldfield of the central region.

The area under discussion is extensive, for it embraces the country between latitudes 30 and 35° south. The western boundary is the sea and the eastern boundary is formed approximately by the line of longitude 71° west. Other territory between the northern and southern limits contains gold, but nearly always it is subsidiary in value to that of the copper, for which metal the ores are being mined. Throughout the whole region the climatic conditions are excellent. Good labour is obtainable, transport is easy, and as the district is agricultural, supplies are plentiful. There is generally a sufficiency of water for all operating requirements, but as a rule, hydraulic power would be costly to instal.

The Chilean mining law is simple and concise. Clear and definite titles are easily obtainable and the whole sense of the law is in favour of the miner as opposed to the agriculturist. No royalties are paid, the only tax being the yearly payment of 10 pesos (about 8s. 6d.) per hectare (2·471 acres) per annum for mining property and 50 cv. (5d.) per hectare per annum for alluvial property. There is no practical restriction to the area that it is permissible to hold. A serious failing in the law is that the mere payment of the annual rental gives undisturbed possession, so that many good mines are thus withheld from exploitation. All the gold produced may be sold to the national Mint, which makes a purely nominal refining charge, but does not pay for the silver. The Mint pays in gold coin. All salaries and supplies, however, are paid in paper money, so that, by reason of the great variability of exchange, some curious results arise. At the moment of writing exchange is low, the kilogramme of gold being worth 4300 pesos as against 3300 a few months previously. Inversely, a miner's wage at 5 pesos per day was worth about 4s. 2d. and is now worth only 3 shillings.

The whole of the long territory under discussion is situated on the coastal foothills of the oldest or outer Chilean mountain range. This range, which is approximately parallel with the Andes, has been denuded until it represents little more than a chain of high hills. From the centre to the southern limits, the prevailing rocks contain considerable amounts of iron pyrite. This pyrite always carries some gold, which, in places, is sufficiently concentrated to have attracted the miner's attention, but never with profitable result. Near the town of Talca there is a large deposit of low-grade bog-iron ore formed from the decomposition of this pyrite. The rocks of the range in general are dioritic or andesitic, with occasional beds of limestone, and one large bed of conglomerate. The limestone, in places, takes the form of marble of good commercial value. The foothills, however, consist almost entirely of granitic rocks, diversified by rhyolitic flows. Aplite is found forming the high points near the centre of the region. There is a narrow strip of steeply inclined schists found forming the coastline between the port of Los Vilos and the mouth of the river Limari. Many of the most interesting mines are on, or near, the contact of these schists and the granite. Throughout there exists a complex system of andesitic and dioritic dikes, which, in every case examined by me, appear to have been intruded subsequent to the vein formation. These have had a markedly favourable effect on the gold content of the veins they intersect.

The veins usually strike east and west with a southerly dip, while the dikes strike north and south, dipping east. These veins are not particularly large, but widths of 5 metres are observed, the average being about 1 metre. However, they have considerable length and the ore-shoots are long, frequently reaching 300 metres. The walls are straight and well defined. For each separate vein system there appears to be a marked parallelism of its units in dip and strike; this applies to the dikes also. A feature of the andesite dikes is their plain smooth walls and the remarkably clean cut that they make through the veins and country rock. They appear to have moved the veins a few inches in every case. In the smaller dikes, sometimes only 10 cm. wide, the andesite is homogeneous, but in those of one metre and over, the outer edge, often accompanied by a clay selvage, contains a lower proportion of the ferro-magnesian minerals, while toward the centre small porphyritic crystals of felspar occur. The dike-rock is invariably fresh looking and shows no mineralization or decomposition.

The richest ores are found in close proximity to the dikes, and in many of the mines the gold is contained in bands of fine-grained pyrite, and even in ores of 500 gm. per ton no free gold is visible, although 65% is extractable by amalgamation. The outcrops as a rule are poor, it being not until a depth of 20 or 30 metres is reached that rich ore is found. It is partly for this reason that so little work has been done.

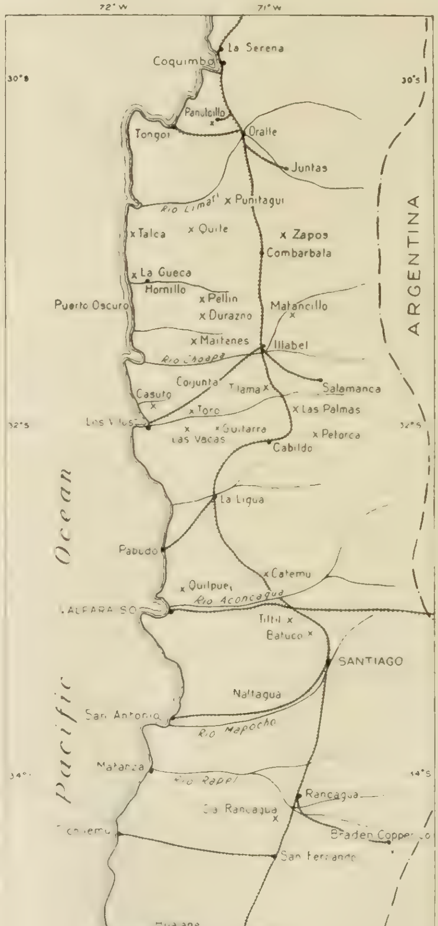
It must not be assumed that heavy gold does not occasionally occur. For instance, the Compañia Minera de Putú, formed in 1911 to work a wonderfully rich deposit discovered in the extreme south, made some shipments of coarse gold. This orebody was proved by subsequent work to belong to the type known in California as a 'pocket.' One shipment of 40 kilogrammes of ore from this property gave 9·5 kilogrammes of gold, and one single stone weighing 65 kilogrammes contained 45 kilogrammes of gold. A feature of the metal from this mine was its fineness, being about 960 as a rule.

A large low-grade deposit is being developed by the Compañia Minera de Oro de Rancagua, at Rancagua, where, however, the ore is complex, an average sample giving the following analysis: Gold, 6 gm.; silver, 30 gm.; copper, 2·5%; lead, 7%; zinc, 7%; together with considerable iron and arsenical pyrite. This company has done sufficient work to indicate a minimum of 300,000 tons of this ore, but does not seem able to achieve any definite result. The gangue is partly quartz and partly rhyolite. The country rock is granite. The orebodies appear to have a considerable extent, with a width of 10 to 15 metres.

In the Talca district there are several old mines of much fame, such as the Chivato, Lomas Blancas, and others, that came to a stand-still when the oxidized ore gave out and the deeper ore ceased to return a satisfactory profit by amalgamation. At the Chivato mine there are some 10,000 tons of dumps that are said to be worth 15 gm. per ton. This mine is, I believe, flooded.

Farther north, and more truly in the gold belt, is the Curacavi mine. This property is equipped with a 30 ton mill and cyanide plant, but it was found after the mill was built that the ore, although extremely abundant, is of too low grade to pay on such a small scale. The average content is about 8 gm., and I am informed that there are 150,000 tons of this grade indicated by the workings.

In the Tiltil region, close to the capital, many gold mines were previously worked, but are now abandoned. Coming farther north to Los Vilos, one arrives in the centre



Part of Central Chile, showing the Position of Gold and Copper Mines.

THE LAS VACAS GOLD MINE, REOPENED RECENTLY. IT IS ABOUT 20 MILES FROM THE COAST, AND 70 MILES NORTHEAST OF VALPARAISO.

of the region. An important company is operating the Las Vacas mine at 25 kilometres from the port. I shall describe this property later in this article.

Immediately north of Los Vilos, and on the coast, is a large and previously rich, deep alluvial district on Casuto creek. The gravel area, known to contain gold, covers about 15,000 acres; sometimes it reaches a depth of 50 metres, but generally it is much shallower. All the gravel carries some gold, but the heavy gold and rich sediment are found down on the bedrock, which is a decomposed schist. Water could be obtained at some expense for the systematic sluicing of this gravel, and, from hearsay, supported by the observations made during a short visit, I conclude that this district has a future, if exploited by experienced people.

Farther north, in Puerto Oscuro, is the La Cueca, owned by an American, who has developed some 10,000 tons of 30 gm. ore. The vein is 4 ft. wide and the ore-shoot appears to be about 300 metres long. A shaft is down 80 m. on the vein. The mine is equipped with a Elspass mill and concentration plant operated by water. This mine might develop into a good property if the necessary capital could be obtained.

Near the above is the Talca mine, operated by a Chilean, who has just equipped it with a Tremain stamp mill and a concentrating table. The vein has been worked over a considerable distance on the surface; in the present workings it is 5 ft. wide and carries 35 gm. per ton.

In the Punitaqui, Puerto Oscuro, and Illabel districts many small mines are being worked, the ores being ground in the native Chilean mills with stone runners. Many of these mines hold out very enticing prospects for small syndicates. Certainly they are of sufficient promise to warrant the expenditure of capital in systematic development.

In addition to the above purely gold mines, throughout the whole region, but more especially on its outskirts, there are large deposits of low-grade copper pyrite carrying from 3 to 6 gm. gold per ton. The Quile mine, worked by open-cut, is estimated to contain over a million tons of 2% copper pyrite carrying 4 gm. gold per ton.

This completes the general review of the region, but, before concluding, I give the following summary of the Las Vacas mine.

The mine of the Compañia Minera Las Vacas has been worked for a century at least. The company has recently been reconstructed and the capital increased to 2,000,000 pesos (about £80,000); it owns 300 acres, which cover at least five known veins, of which, however, only one, a composite vein, has been worked to any extent. These veins run S 80° W, dipping south at 70°. In the workings the veins are crossed by six dikes of andesite, which strike N 80° E and dip at 80° east. The ore-shoot was 250 metres long on the outcrop, and has been worked to a depth of 300 metres. In the bottom levels this ore-shoot has been opened for a distance of 100 metres and here is rich still, although the average width of the vein appears less than the average of 4 metres in the shallower workings. In the main bottom level, 260 metres

THE MILL OF THE LA VACAS CONTAINS 10 STAMPS; 65% OF THE GOLD IS EXTRACTED BY AMALGAMATION AND 31% BY CYANIDATION from the surface, a cross-vein, striking northeast and southwest, dipping southwest, has been found, averaging 1·50 metres wide and carrying 40 gm. of gold per ton. It is believed that this same vein has now been met in the old workings at the shallower levels. It was passed by the ancient workers because at its junction with the Las Vacas vein it is broken and very low in grade. It carries much galena and the gold is only 630 fine. There is now no doubt that the cross-vein represents the oldest fracture, the Las Vacas vein being second in order of formation and the andesite dikes representing the last of the phenomena. The ore varies in value considerably, but, from extremes of 500 gm. to 10 gm., the average over 10,000 tons is 26 gm. The fineness is 850. Many of the old stopes still carry fillings that yield 20 gm. and over, and the old pillars frequently carry 150 gm. per ton. Close to the dikes small tonnages have been developed that have yielded 50 gm. and over. The gold is rarely visible; it is disseminated in a free state in finely granular pyritic stringers contained in a white and almost barren quartz. Sometimes these stringers attain a width of 30 to 40 centimetres. There is, even on the bottom levels, virtually no copper present, which is a distinct peculiarity in Chile.

The pyritic concentrate contains generally 120 gm. per ton, but 65% of the gold is easily amalgamable. The parallel veins, while not apparently so high in grade, all carry 20 gm. and over, and the company is considering plans for their development. Parallel with the Las Vacas vein system is another of good appearance, but not as yet seriously worked. Two of these veins are mentioned on the government map as mines of importance.

The Las Vacas company is operating a 10-stamp mill, crushing to 30-mesh, with inside and outside amalgamation. The pulp passes to a Dorr simplex classifier, which is in closed circuit with a 3-ft. tube-mill and amalgamation tables. From the classifier the pulp, 87% passing 200-mesh, proceeds to a Dorr thickener and thence to Pachuca vats and a Moore filter plant. Agitation in 0·1% cyanide solution for 12 hours is sufficient to dissolve the gold. The tailing from the filter carries to the dump an average of 0·5 gm. Cyanide consumption is high. Of the gold 65% is extracted by amalgamation and a total recovery of 96% is obtained. The mill, when worked at full capacity, is capable of treating 40 tons in 24 hours. I regret that I am not at liberty to give the detailed costs on this property, which is the only one in the whole region that is being worked on modern lines.

However, to replace the lack of this information, I here append a list of the principal rates of pay and the prices of materials. To avoid confusion I have translated all prices to sterling:

		£	s.	d.
Rock-drill men	per day		8	0
,, ,, helper	,,		4	2
Hand miner	,,		5	0
Labourer	,,		3	4
Pump-man	,,		8	1
Timber-men	,,		7	9
Mason	,,		8	4
Mine shift-boss	per month	12	10	0
Blacksmith	,,	8	0	0
Mill shift-boss	,,	10	0	0
Mill-hand	per day		6	0
Stoker	,,		6	6
Coal, per ton f.o.b. cars in port of delivery		2	8	4
Firewood, approx. per ton			13	4
Paraffin, per case			13	0
Oregon pine, per board foot				3
Cement, per barrel			18	0
Cyanide, per kilo (130%)			2	6

and all other supplies and wages in the same proportion.

There are various good reasons why so little work has been done on these orebodies, and among them is the chronic lack of capital and equally chronic bad management, involving the failure of several ill considered concerns and a general lack of confidence. An important reason for this state of affairs is the absence of custom plants for the treatment of small lots of gold ore, so that all those that are too low in grade to permit shipment to Europe, or to permit the payment of a high smelting charge in the local copper smelters, are of no value.

There is no doubt whatever that very many good properties exist in the field discussed, although the fact that they must be approached from the virgin and undeveloped state detracts from their value when presenting them to capitalists, as the market exists today.

In the above article, the author uses metric weights and measures, and we have not converted them to English units, for the reason that in South America the metric system is customarily used. For the benefit of readers we add the following conversion figures:

1 gramme	= 15·43 grains
1 gramme	= 0·643 pennyweight
1 pennyweight	= 1·55 grammes
1 ounce troy	= 31·1 grammes
1 ounce avoirdupois	= 28·35 grammes
1 pound avoirdupois	= 2·2 kilogrammes
1 kilogramme	= 0·4535 pound avoirdupois

DISCUSSION

Stripping Placer Ground.

The Editor:

Sir — The land dredge described in the article by Mr. C. W. Boise on the diamond mines of German South-West Africa, and illustrated on the cover of the Magazine for June, suggests one or two questions. Has this machine or anything of its type been used in working placers? If not, do you think it could be so used to advantage? It occurs to me that it might be profitably employed in connection with sluicing, to work deposits where the pay-gravel is covered with clay such as often robs sluices, or even where rich pay-gravel is found under barren cover upon a bedrock so rough that it can only be cleaned by careful work after thorough stripping. The proposed arrangement would not, of course, be feasible where work is necessarily carried on below water level. The latter is, however, by no means a universal condition in gold dredging. Even where it was necessary to work below water level, would it not be possible to operate with two machines, the first stripping and the second digging and washing the pay-gravel as on an ordinary gold dredge? While there would be mechanical difficulties in building such a land dredge, mainly in distribution of weight, and operating charges with two machines would necessarily be higher than with one, the arrangement would make possible the handling separately of overburden and pay-gravel. Has it been tried?

E. D. Edwards.

London, June 17.

[So far as we know, the plan suggested by our correspondent has not been tried in gold dredging, though there have been many attempts, all failures for one reason or another, to develop land dredges. The fundamental difficulty seems to be that ordinary placer ground is not rich enough to stand the expense of re-handling, and no land dredge has been built that retains its mobility and disposes of the tailing as simply as the ordinary gold dredge, which merely drops it overboard. They become buried in refuse, or the expense of handling the refuse becomes prohibitive. However, with rich shallow ground and a troublesome clay cover, Mr. Edwards' suggestion, like the rat hole of which Abraham Lincoln wrote, will "bear looking into." The plan of working has the distinct advantage of stripping and laying open to daylight a succession of long narrow belts such as are almost ideal for sluicing operations, if water can be brought to the ground and the relatively small amount of tailing from the sluices be disposed of conveniently. We are not aware that this has ever been done. The French have used an excavator, notably on the Panama Canal, working on the land and employing a bucket line similar to that discussed. Delivery of material was, however, to trucks on the land side. The plan of using a conveyor belt and throwing the refuse back over the area stripped was employed in the United States nearly twenty years ago, though there the excavation was by means of four small steam shovels delivering to belts parallel to the edge of the pit and thence to the cross belt. The steam shovels dug toward the machine in reverse of the usual method, just as the bucket line does in the machine under discussion. The American excavator was used for digging clay which was mixed with coal and piled in ridges, very similar to the sand in South-West Africa, preparatory to burning for railroad ballast. Oddly enough, two machines were used for different parts of the work, one following the other, as planned by our correspondent. The work was described in 'The Mineral Industry' for 1897. No costs of excavating alone are available. From those of the whole work it would seem that in Iowa in 1896 the digging cost considerably more per yard than the present cost of gold dredging in California. It should also be noted that these machines so far as developed are small and light. To handle deep heavy ground they would require remodelling. Our correspondent is, we assume, familiar with the excellent work done in Siberia, Alaska, and other countries with the drag bucket scraper, which though a discontinuous machine, finds a distinct place for itself. The work, too, of long-arm steam shovels in stripping coal in Kansas may be mentioned. It remains to state that the problem of an overburden of clay has been met in certain California placers by cutting a bench down to the gravel, operating with a by-pass so that the material does not pass over the sluices, and then dredging the gravel alone. This slows the work and increases the cost, as each forward cut is made in duplicate, but it keeps the clay out of the sluices. We believe that there are opportunities for application of small light machines and also for special apparatus to meet special conditions. Our correspondent's suggestion warrants investigation. May we hear from our friends in the dredging business?—EDITOR.]

Dip of Drill-Holes.

The Editor:

Sir—I notice in the Magazine for May 1915, page 289, a discussion on 'Dip of Drill-Holes' by Mr. E. C. Bloomfield, with comments by the Editor. I wish to call your attention to the several papers that have been written discussing the effect of capillarity in testing drill-holes with hydrofluoric acid and giving curves of correction. Mr. J. E. Jopling wrote a paper on 'Capillary Attraction in Diamond-Drill Test Tubes,' which was published in the Proceedings of the Lake Superior Mining Institute for 1909, page 131. I wrote a paper on 'Surveying and Sampling Diamond-Drill Holes,' which was published in the Proceedings of the Lake Superior Mining Institute for 1911, page 100, which touched upon this point. I also wrote a paper on the same subject for the American Institute, published in the Transactions for 1912.

The tenor of the discussion in your paper would indicate that the writer and the editor were not aware of the information previously published on this subject. Mr. Bloomfield's suggestion of filling the tube with liquid of the same specific gravity as the acid when reading the inclination of the tube is ingenious, but I do not believe it is as convenient, and probably no more accurate than reading the empty tube and applying the correction for capillarity. I think the Editor in his remarks did not understand Mr. Bloomfield's suggestion, for I do not believe it was intended that the second liquid should be placed above the hydrofluoric acid while the test was being taken in the drill-hole, but only while the inclination of the tube was being read.

In this connection, I might call attention to the Maas patent drill-hole compass, which is being used successfully by a considerable number of mining companies in the United States and Russia to determine the direction of drill-holes. I consider that determining the direction is just as important as determining the dip, and this is a point which heretofore has been neglected. With the Maas compass, glass tubes 1¼ in. diameter are used, and the effect of capillarity is only 4° at 45° inclination. This error can be easily eliminated by means of a curve of correction.

E. E. WHITE.

Ishpeming, Michigan, June 7.

[This subject will be discussed further next month.—EDITOR.]

Ore.

The Editor:

Sir—As I observe that the discussion regarding the best definition of the word 'ore' continues, I again tender a contribution.

On your closing the discussion I did not write further. I did not, however, agree with your definition that "ore is rock from which metal can be extracted to economic advantage," inasmuch as though excellent within limits, covering most, it failed to cover much of the ground. It seems to me that the matter of attention or interest is of the essence of the question. If a rock is exploited, or receives serious consideration, with a view to the extraction of its contents, it is called an ore. The word is not restricted to rocks which are or can be worked to economic advantage, nor, in my opinion, is it feasible or desirable to do so. Even in cases where the exploitation or serious consideration is unjustified and is the result of ignorance or knavery, the word 'ore' would undoubtedly be used. We require a word which will designate the rock we may be dealing with when reporting on or discussing the value of the said rock with respect to its extractable contents, a word of general application which denotes that the rock is the main object of our attention as distinguished from other things. The word 'ore,' as I understand it, is generally used in that sense.

With regard to the Editor's second suggested definition that "ore is rock from which the miner may reasonably expect to extract metal to his economic advantage," this is, I think, in many respects better. I think, however, that it is not "expectation" but rather interest or attention which is the essential point. "Expectation" here implies not only the rock being payable but expectation of being able to exploit it. To me the two things appear much apart. One might be satisfied that a deposit of profitable rock existed at a certain place but he might not "expect" to be able to find the necessary capital to exploit it. He might, therefore, not "expect" to exploit it to his advantage, yet he would call his rock 'ore.' He might hope to exploit it to his advantage and work hard to that end.

I think it is better that the word should not be restricted to rocks containing extractable metals. The word may be useful to apply to rocks containing other substances which are extracted and I believe that the word is often used in connection with these. This point, however, is not of such importance as others.

I think also that it is unnecessary to state that it is the profit or economic advantage which is sought. It is, in fact, hard to conceive any other motive than that of profit, direct or indirect, whether to the owners, the workers, the community as a whole, or to speculators at the expense of the community. In the last case the motive is "supposed" to be that of actual profit on the work, at all events while work is proceeding.

I suggest the following definition as covering the requirements more correctly than any I have yet seen put forward: "Ore is rock, the value of whose metal (or other) contents causes it to become the object of attention with a view to the extraction of those contents."

I have read carefully the various letters from different engineers to the Magazine, and noted the different examples quoted as different mineral deposits and different circumstances affecting them, and I can find no instance which the above definition does not cover, nor have I in mind any instances which the definition will not cover, if applied sympathetically. It covers such cases as rock whose profitable exploitation is considered doubtful, or as to which competent opinions differ; rock unprofitable though similar to other profitable rock because of circumstances (width, nature of wall-rocks, locality, too much or too little water, etc.); rock which, though unprofitable at the moment, may become profitable; rock which, though worked in the expectation of profits, has failed to yield profits; rock worked knowingly at a direct loss because of supposed indirect gain (such as might be effected by a state); rock which, having received serious attention (even to the point of actual operations) has been agreed upon without reservation as being unprofitable; rock which has been worked, although it never legitimately promised profits for marketing purposes; rock which, though estimated to be profitable, cannot be exploited because of failure to secure capital. The definition plainly implies that the existence of certain contents is already established in such proportions as to cause it to become the object of attention in regard to the extraction of the contents.

It appears to me that several writers on this subject see difficulties where none exist, through contemplating the widely varying natures of different ores, and therefore assuming it to be impossible to find a definition to apply to all cases, even all cases for practical purposes. It appears to me that in these cases the difficulty is brought about through the wrong standpoint being taken. The essence of the matter is the attention or interest. It is the attention given to a rock, beyond the preliminary testing, in the hope or expectation that it has certain contents in such proportions as to pay for extraction, that causes the rock to become an ore. I put in the qualification of "beyond the preliminary testing" because the attention given (for instance by the prospector) in the first case in testing the presence of certain contents and certain quantities thereof do not constitute an ore.

It seems to be now agreed by most engineers, including yourself, that the matter of profit cannot be made a condition of an ore. It is not certain that any material is profitable until the profits have actually been made, and we must use the word 'ore' before that stage is reached. It might be feasible to impose the condition that a rock to be an ore must be supposed or estimated to be profitable. In my opinion, such a condition is undesirable. Of course, in the great majority of cases it is the fact. A definition as follows:

> "Ore is rock whose contents it is estimated can be extracted at a profit,"

or more in the form of your own definition—

> "Ore is rock from which the miner estimates that metal can be profitably extracted"

might be considered suitable by some.

The fact that there may be substances which come within the limits of the suggested definition, but which are not called ores, is no serious objection. In such cases it is not suggested that the word need be used. There is no need, indeed, to use one word if another word is available and correct. In the great majority of cases where rock is being mined, treated, tested, inspected, reported on, or discussed with regard to the value of its extractable contents, we need a distinctive word to denote such rock as apart from other rocks or other things. That word is 'ore.' Where other words suit specific cases and are preferred, I cannot see that this affects either the definition of the word 'ore,' or the fact that it is highly desirable to have a satisfactory definition for it.

H. R. SLEEMAN.

Perth, Western Australia, May 17, 1915.

SPECIAL CORRESPONDENCE

TORONTO.

EFFECTS OF THE WAR.—The prospecting and development of new mineral areas has greatly fallen off this year owing to the war and the tightness of money. The officials of the Department of Mines at Ottawa state that very few new claims in the West are now being recorded. Development of claims previously staked is also retarded, and the Department has many applications for extensions of the time in which assessment work is required to be done.

PORCUPINE.—The record of the Dome Mines for May shows a considerable increase in the tonnage treated, and a larger production than in any previous month with one exception. The value of gold produced was $111,361, from the treatment of 26,000 tons of ore. Driving on the 6th level has been energetically pushed for 125 ft., opening an orebody stated to assay about $10 per ton. At the annual meeting of shareholders held on May 25, a letter was read from President J. R. De Lamar to the effect that, as it was now possible to forecast results from the mill, it was the intention to place the stock on a dividend basis. It was proposed to double the capacity of the mill within the present building, and when this was completed to build a much larger mill according as the tonnage developed, with the money now being received for the new issue of stock. Consignments of machinery have already arrived. The regular 4-weekly statement of the Hollinger for the period ended May 20 shows a fall in production, the gross profits being $139,187, as compared with an average of about $150,000. The quantity of ore treated was 23,821 tons of the average assay-value of $9·56, the working costs being $3·54 per ton milled, being a further reduction of 17 c. per ton. The cause of the decrease of the output was the necessity of catching up development work, which had been allowed to slacken during the early spring on account of power shortage. As this was largely in comparatively low-grade orebodies the average grade of the ore treated was lowered.

COBALT.—During the month of May the Nipissing mined ore of the estimated net value of $175,523 and shipped bullion of the estimated net value of $277,671 from Nipissing and custom ore. Hydraulic operations have uncovered several small veins on the surface near Peterson lake, and are now being conducted on the territory east of Cart lake. The Chambers-Ferland has made connection with the northern workings of the Nipissing at the 350-ft. level, and is cross-cutting near the Nipissing boundary in the hope of discovering extensions of the veins of that mine. The Timiskaming recently shipped the richest car-load of silver ore that ever left Cobalt. It contained about 42 tons of ore carrying approximately 308,000 oz. of silver, taken from the 400 and 500-ft. levels.

The Keeley mine, in South Lorrain, an outlying district of Cobalt, which after a chequered career was closed about eight months ago, is being re-opened. Some promising veins cut last autumn will be developed.

COPPER REFINING.—The project for some time under consideration by the Canadian Government for the establishment of a copper refinery in Canada to meet the demand for copper and brass for shell making, is beginning to take practical shape. A conference was recently held at Ottawa between the military authorities and W. D. Matthews and C. D. Warren, two Toronto capitalists, at which preliminaries were discussed. As Mr. Warren is president of the Consolidated Mining & Smelting Company, a large copper-producing concern, it is likely that the projected refinery will be at Trail, near the plant of that company.

MELBOURNE.

DROUGHT.—The problems that face Australia to day arise less out of the war than from the drought. We had been ready to accept a short harvest, worse even than in 1902-3, and to fill the gap for home consumption and seed wheat with imports, but we cannot now view without fear the slow progress of the months, with water supplies drying up and stock perishing in vast numbers. The immensity of the war issues have been dimmed before the perils of this home disaster. If rain does not fall copiously before this letter reaches London the situation will be desperate so far as the pasturalist goes, and serious to the agriculturist. Personal expenditure is already being curtailed, and sails are being shortened in a way that Australia has not witnessed since the financial crisis of the early eighties.

[Recent cables show that rain has fallen, though not yet in the quantity desired.—EDITOR.] As an offset to this agricultural crisis, it is gratifying to be able to record that mining conditions have improved lately.

BROKEN HILL.—The check administered at the start of the war to Broken Hill and the different copper regions has been overcome. More labour is being employed, and the necessities of the day are forcing the worker to give a higher efficiency than heretofore. Three great companies, the Broken Hill Proprietary, South Broken Hill, and the North Broken Hill, have each paid a substantial dividend, and the promise is practically made that disbursements are to be continued. These may not be on the regal scale of heretofore, for only lead is now produced. Moreover a smelting plant is as yet not available to treat all the lead concentrate of the district. But the day is not far distant when that position will be changed, seeing that the merger scheme negotiated by the Baillieu-Lionel Robinson group by which the Proprietary's Port Pirie smelters pass to co-operative control has been completed. The evolution of the lead market and of Barrier mining interests under the new regime will be followed with close interest. Will the trade now snatched from German hands be kept permanently, or will the Teuton forces that before compelled a submission be able, when hostilities are over, to demand the right to co-operate? The company that gains most by the merging is the Proprietary. Its lead-ore reserves are getting down to a low point, and it has drawn largely on its stock of zinc tailing. In a few years its Port Pirie works would have stood idle. Now the company gets £400,000 for them, and it secures a paid-up interest in the smelting combination. What is most interesting from a personal standpoint is to see the old contending parties at the Barrier working together in amity. They no doubt will be united, when they have to meet labour demands in June for a much higher wage than even the liberal scale now in force.

MARKETING COPPER.—A scheme for merging the selling business of the big Australian copper mines is adumbrated in an article appearing in the Melbourne *Age*. This article hints at a benevolent arrangement whereby the selling, and possibly also the refining, of copper produced in Australia shall be merged. If there be anything in the suggestion it is not hard to outline what could be done. The interest of such concerns as the Hampden, Mt. Elliott, Mt. Morgan, and Mt. Oxide are not separated by a very wide gulf. As a matter of fact the whole of the properties could be merged, if the old element in Mt. Morgan were willing, and a marvellously strong combination would be created. Then the refining organization at Port Kembla in New South Wales, owned now by the Mt. Morgan and Aron Hirsch interests, could be utilized for the joint requirements of the combination. The output of the refinery could be sold through the one channel. The obstacle in the way of the copper merger, as with the lead merger, is the socialist tendency to conserve monopolies or semi-monopolies for the State. At the present time, it is not likely that all the copper companies would join the merger. Of these the most important is the Mt. Lyell. Up to a short time ago this company had all its refining done in the United States, and only recently transferred its business to the Port Kembla works in New South Wales. Most people would like to see Mt. Lyell join with the others in the new scheme.

GOLD.—Gold-mining is in a depressed condition throughout Australia. The only bright spot recently has been the Edna May, near Southern Cross, West Australia. Here an oxidized orebody, that was none too promising on the surface, has been developed to a depth of 225 ft. The average content is 25 dwt. per ton, and as the ore is soft and easily mined, large profits are being made.

NEW YORK.

ZINC AND LEAD.—Under the existing circumstances, it is to be expected that the metal market should be the scene of spectacular performance. The copper shares have been pushed aside by the spelter stocks and some of the cheaper lead-producing concerns. It has been generally supposed that the frantic bidding, which forced spelter up to the high mark of 29 c., was due to the demands of manufacturers of brass, who have been unable to close their contracts until they were assured of the necessary supply of spelter. There is just appearing a story to the effect that this market has been manipulated by German agencies in attempt to embarrass the production of brass makers. The attempt at a corner, it is stated, met with so much opposition that the price of spelter has fallen in a few days from the high prices to 18 c. Producers now refuse to make any sales except for genuine consumption. A few days since the American Zinc, Lead, & Smelting Co. was said to have bids of 32 c. for its Mascot brand as far ahead as October delivery, this spelter being almost wholly free from lead and much desired by brass makers.

The American Smelting & Refining Co. took the lead market in hand and, after the price had climbed up to 7 c., established a price of $5\frac{1}{2}$ c. The smaller mining companies in the Cœur d'Alene have been reaping a harvest, as well as the low-grade zinc and lead producers of the Missouri district. One of the oldest mining districts in the United States is the southeastern Missouri, where are the properties of the St. Joseph Lead Co. The control of this company is said to have been acquired during the past few days by the Remington U.M.C. Co., which has also bought the Robin Hood Ammunition Co. One lead company, largely floated in London some years ago, is the Utah-Apex, whose property adjoins that of the Utah Cons. in Bingham Canyon. The British holders of Utah-Apex never had an opportunity to get out without loss until the recent advance in the metal, when the shares responded by moving up to \$5·25 per share. At this price there was considerable selling for London account. The company makes lead at a cost of about $3\frac{1}{2}$ c. per lb. and could show profits for the shareholders if the high prices for lead could be maintained for a time.

COPPER MINES. — The Arizona Copper Co., which is a Scotch concern, is now reaping the benefit of its recent campaign of rehabilitation. Some two years or more ago, the company enlisted the services of L. D. Ricketts and proceeded to rebuild its plant; now it is turning out more than 4,000,000 lbs. of copper per month, and is securing profits far beyond anything heretofore in the history of the company.

The newest star among the coppers is the Kennecott Copper Corporation, which has just been introduced to the public under the sponsorship of W. B. Thompson. The concern is a reorganization of the Kennecott Mines Co. which was controlled by the Alaska Syndicate and includes the Bonanza, the Jumbo, and the properties of the Beatson Copper Company. The Bonanza, which began production in 1912, has been the record low-cost producer of the world, making its copper at an average cost of $4\frac{3}{4}$ c. per lb. Dividends have been paid to the Alaska Syndicate of \$7,500,000; the holdings in the Alaska Syndicate were divided equally between J. P. Morgan & Co. and the Guggenheims. The Jumbo mine nearby is just ready to start production and the Beatson output is to be increased. The combined output of the three is estimated at approximately 5,000,000 lb. per month. It was to develop the Bonanza that the Morgan-Guggenheim syndicate expended \$18,000,000 in the building of the Copper River railroad. The new Kennecott company has one feature unusual for a mining organization; its 1,120,000 shares are without par value. If there exists an instance where the placing of a par value upon corporation shares is meaningless, it is in the case of mining companies, since the property value is continually changing, through constant liquidation. In rails, or in industrials where good-will does not figure too largely, it is possible to estimate plant or property values against outstanding capital, but in mines, the shares surely should represent only a certain proportionate interest in the enterprise. The Kennecott has sold \$10,000,000 of convertible bonds, the holders of which may, after two years, exchange them for stock on a basis of 40 shares of stock for one \$1000 bond; this gives the stock a theoretical value of \$25, while it is selling in the open market for above \$30, on the prospect of earning \$7 per share for the year, or possibly better if the copper market holds.

SAN FRANCISCO.

COPPER.—Copper smelting has reached its highest development in the United States, where there are more smelting plants than in all the rest of the world. It might be thought that this country was well supplied with copper smelters, since several of the present ones have recently been enlarged or rebuilt, but it has been necessary to erect a new one to take care of the output of concentrate from the Inspiration and Miami mills. This has been under construction for the past year and was started late in May. It was built at a cost of approximately \$2,200,000 by the International Smelting & Refining Co., a subsidiary of the Anaconda, which controls the Inspiration. Wedge furnaces are used for drying the concentrate before sending it to the reverberatories. The ore is not roasted, as it barely contains enough sulphur to yield a matte of the proper grade. The dust from the drying furnaces is caught in a Cottrell plant. Oil is used as fuel throughout and all the smelting is done in reverberatory furnaces. At the Anaconda new reverberatories are being built 25 ft. wide and 144 ft. long, as compared with those 19 by 112 ft. previously in use. This is because powdered coal is being used as fuel, making more combustion space necessary, hence the higher and wider arch of the roof. On the new furnace 1 ton of coal smelts

7 tons of charge, as against $4\frac{1}{4}$ tons in the smaller furnaces. Smelting costs now have been reduced to so low a figure that there is not much room for improvement, and progress in copper metallurgy is in the future likely to be in wet processes for copper extraction and in the dressing of ores preparatory to smelting.

FLOTATION.—Flotation is making rapid strides in the dressing of copper ores, and a surprisingly large number of plants are using it in one form or another. Naturally, they say little about it, as the Minerals Separation is still engaged in suing the principal users who have not made peace with it. Even if the Minerals Separation wins the suit now in progress against the Miami, the company will have lost a great deal, for experimenters everywhere have been busy trying to find a way to get around the Minerals Separation patents, and seem to be having fair success. The trouble with the Minerals Separation process is that the agitation requires considerable power, which is expensive, and there are a number of methods, some not yet announced, that get a satisfactory result with less power cost. The case of the Minerals Separation is much like that of the clergyman who governed his sons so sternly that they all ran away from home, and its troubles are largely due to a lack of appreciation of the American temperament. The directors would have done well to study the experience of E. A. C. Smith and W. H. Peirce, who first made a success of using a basic lining in a copper converter. When they came to collect royalties on their patents, the smeltermen told them that they considered their patents of no value, as the essential features had been covered by earlier unsuccessful experimenters, but that they were greatly obliged to Smith and Peirce for teaching the profession how to make the process work. The smeltermen therefore refused to pay royalties, but offered to settle for a lump sum, which Smith and Peirce wisely accepted. Meanwhile the metallurgists at Great Falls brought forward their type of converter, which is even more satisfactory than the Smith-Peirce. If those two gentlemen had stood out for royalties they would have received practically nothing ; as it was they received a great deal of credit and a comfortable fortune.

CHINESE MINING.—Opportunities in mining in China are being brought to the attention of the American public by H. V. Liang, general manager of the Shui-Kou-Shan mine, in Hunan, who is touring the United States with the party of Chinese business men who are being entertained by the Chambers of Commerce of the United States. The Shui Kou-Shan mine, which is described in the *Mining and Scientific Press* of June 12, is the most important zinc-lead mine in China, having produced in 1914 some 23,000 tons of 36% zinc ore and 7600 tons of 74% lead ore containing 30 oz. silver per ton. The ore is sent to Europe for smelting, but when, in the course of a year or so, the contract with Carlowitz & Co. expires, the lead ore, at least, will be smelted near the mine. This mine is under government control, but the people interested in it own a number of lead, zinc, and tin mines that are still in the prospect stage and it is for the development of these that American capital is desired. Railroads are in process of being built across the most promising mining regions of southwestern China and the scheme of co-operation proposed by Mr. Liang seems the most feasible for the exploitation of the undoubtedly valuable mineral deposits of that region.

ANTIMONY.—Speaking of China naturally leads to the subject of antimony, since the largest part of the world's production comes from the region just under discussion. Much of the antimony supply of Europe formerly came from the La Lucette mine, in France, but that famous mine is now about worked out. The deposits in Hunan province are of unknown extent, but more than sufficient to supply all the world's needs in normal times, while valuable deposits exist in many other provinces. However, the war has caused such a sudden increase in consumption that the mines cannot meet it at once, and as a result the price of antimony for quick delivery has gone up to 35 cents per pound as compared to the 6 cents that ruled about a year ago. As a result the Chapman Smelting Co. has re-opened the antimony smelting plant it built near San Francisco some years ago, and mines in Idaho and Alaska are shipping antimony ore. A smelting plant has also been built near San Luis Potosi, in Mexico, and before long a larger supply will be available. As far as these companies are concerned, the business is a purely temporary one, since the Chinese are undoubtedly increasing their output and will be in a position to supply all the world's needs when the market goes back to normal conditions. Of course, the local plants will always have the benefit of better freight rates, but this is apt to be over-estimated, for a comparatively few miles of railroad haul frequently costs as much as steamer rates halfway around the world.

PERSONAL.

A. H. ACKERMANN is here from Rhodesia.

J. A. AGNEW is back from Nicaragua.

JOHN BIRKINBINE died on May 14.

F. L. BOSQUI, who recently withdrew from the Johannesburg staff of the Rand Mines Ltd., has been retained by the same firm as consulting metallurgist, with headquarters in London.

A. A. BOYD has been appointed acting general manager for the Mount Morgan company.

WILLIAM BRADEN has gone to Chile to develop a newly discovered copper deposit.

F. W. BRADLEY has gone to Hawaii to rest and recuperate.

GILMOUR E. BROWN has gone to Dutch Borneo from China.

WALTER LYMAN BROWN has returned to West Africa.

T. H. DAVIES, of Melbourne, has a commission with the Royal Welsh Fusiliers.

FRANCIS DRAKE leaves London for Rhodesia on July 28.

H. M. DRAKE, son of Francis Drake, was killed in Flanders late in June, while leading his men in an attack on the German trenches.

A. STANLEY ELMORE has returned from the United States.

ALFRED FOX Jr. has a commission with the Royal Field Artillery and has gone to the front in France.

COLIN FRASER has been inspecting alluvial gold deposits at Nullagine, West Australia.

J. L. GALLARD has joined the Army Service Corps Motor Transport, and is at Pennington camp, near Chislehurst.

R. M. GEPPERT is in the United States and intends to go to the El Oro district in order to make an examination of the Esperanza.

REIJI KANDA is examining properties in Burma.

A. E. KITSON is here from the Gold Coast, West Africa.

J. S. MACARTHUR is producing radium bromide at a new factory on Loch Lomond.

A. M. MACKILLIGIN has received a commission in the Highland Light Infantry.

J. H. MACKENZIE is managing director for the Alaska Juneau company.

BENJAMIN MADEW has been appointed consulting engineer to A. Goerz & Co. in place of W. McC. Cameron, who has resigned, the appointment to take effect in 1916.

T. BRUCE MARRIOTT has returned from the Argentine.

J. T. MARRINER, manager of the Pahang Consolidated, is in London.

GEORGE B. MASSEY has left the Bucyrus Company and has taken offices in the People's Gas Building, Chicago, as consulting engineer for excavating machinery.

GEORGE V. MICHELL has returned from Northern Nigeria.

J. T. MILLIGAN is at Sheba, Transvaal.

C. H. OLIVER left West Africa on June 23 for England.

J. S. OLVER has returned to the Rand after being in England for a year.

J. L. POPHAM has been appointed resident engineer for the Ex-Lands Nigeria company.

FRANK H. PROBERT has given up his office at Los Angeles and has gone to Berkeley, California. He intends to open an office in San Francisco later in the year.

C. W. PURINGTON has left Petrograd on his way to the Lena goldfields.

R. J. D. RICHARDSON has left Ceylon to take a commission in the Indian Army Reserve of Officers.

A. W. ROSS has gone to Burma for the Tavoy Concessions, Limited.

MILLARD K. SHALER has recently been in Belgium on work in connection with the Commission for Relief of which he is one of the honorary joint secretaries.

S. A. R. SKERTCHLY is on his way home from Madagascar.

RALPH STOKES, of the Royal Engineers, has been in London on leave from the front.

E. P. CORBETT SULLIVAN has returned from El Oro, Mexico.

A. ERNEST THOMAS is the manager of lead mines in Shropshire.

E. COPPEE THURSTON has returned to London after several months service with the Commission for Relief in Belgium.

CHARLES F. TROUSDELL is expected home from Nigeria.

F. J. TRUMP, manager of the Ferreira Deep, is captain in the Welsh Guards.

SCOTT TURNER has recovered from the injuries received in the sinking of the *Lusitania*, and has proceeded to Tromsoe, Norway.

J. B. TYRRELL has been elected president of the geological section of the Royal Society of Canada.

EDWARD H. WATSON has left for the Federated Malay States and New Zealand.

D'ARCY WEATHERBE is expected from Canada.

HORACE V. WINCHELL has moved his office to 826 First National-Soo Line Building, Minneapolis.

METAL MARKETS

COPPER.—The standard market had a period of great activity in the early part of the month, each session showing gathering strength, until the price was carried up to £88 on June 14. From that point the market gave way, and lapsed into idleness, and by the month's end the price of three months copper was no higher than £80. The decline was started by the realizations of speculators' holdings, and has been furthered by rumours of Government control of metal prices. There is still a considerable reserve of buying power ready to show itself on an improvement in the market tone. Producers are firm, and having sold well are able to wait until the demand comes. There are signs of an agreement between them regarding prices. The selling has come from second hands. Demand from both America and Russia is active. In this country there has been some buying right over 1916. For electrolytic 20 to 20½ cents is being realized in New York, and £95 in this country.

The present mood of the market is one of great caution. There is undoubtedly a large volume of business to be placed. The metal trades are sharing largely in the enormous spending powers of the Government. Any substantial decline in prices in the near future is highly improbable, whereas on the wave of a new buying movement prices are likely to register fresh high records.

Average prices of cash standard copper : June, 1915, £82. 13s. 8d. ; May, 1915, £77. 14s. 3d. : June, 1914, £61. 9s. 3d.

TIN.—There has been little animation in the market for this metal. Prices have risen from the low level of May. But the market wants a lead, and at present speculators seem indifferent to the possibilities. The difference in prices between spot and forward metal is widening, which will encourage consumers to buy forward. Good prices have been realized in New York, and Russia has become a buyer once more, especially for delivery to Archangel. Stocks in this country have become depleted, and English standard brands have almost disappeared. American stocks in warehouse are also inadequate to the large consumption there. A temporary falling-off in the Straits production is reported. A similar state of affairs prevails here owing to the difficulty in securing labour. Demand is everywhere excellent. The price for the month has varied between £160 and £172 for three months metal, with a rising tendency.

Average prices of cash standard tin : June, 1915, £167. 17s. 3d. ; May, 1915, £162. 18s. 6d. ; June, 1914, £138. 16s. 2d.

LEAD.—The sensation of the metal market has been provided in this generally lethargic metal. The rapid rise to £28 following rises in the American quotation, and the subsequent collapse points unmistakably to manipulation. Supplies have been reaching London with a regularity and plentifulness that should have made for steadiness. The boosting of American prices is undoubtedly connected with share pushing, and has rather bewildered legitimate dealers. It has led to some speculation, and to the storing of supplies in London warehouses. As to these there are sinister rumours of German control which are probably quite baseless. Anyhow the position is interesting. The dissolution of the lead pool has produced unsettlement, and the wildness of prices lately appears to be connected with the absence of control.

Average prices of soft foreign lead : June, 1915, £25. 4s. 1d. ; May, 1915, £20. 7s. 2d. ; June, 1914, £18. 13s. 11d.

SPELTER.—Prices show a welcome decline. American sellers have become less exacting, and the production there is said to have increased 25%. Japanese production also shows an increase, but British has doubtless declined owing to the scarcity of labour. The galvanizing trade has everywhere declined enormously. Efforts are being made in all directions to replace the use of zinc by other alloys, with varying success. The Dutch government has prohibited the export of spelter. Russia is in the market, but it is difficult to get the metal to satisfy her demands.

The question of treating Australian zinc concentrate in this country is officially stated to be still under consideration, and a committee has been appointed by the Government, under advice of various technical societies, to inquire into the position and make recommendations. The zinc problem as it affects the Allies is discussed elsewhere in this issue.

Average prices of good ordinary brands : June, 1915, £100. 12s. 3d. ; May, 1915, £67. 19s. ; June, 1914, £21. 6s.

SILVER.—The market has been quiet and dull, and the price has weakened, now standing at 22⅞d. per oz. standard.

ANTIMONY.—During the last month the quotations have remained practically unaltered at from £110 to £125. Some of the old mines in the west of America are being reopened, and their product treated at the Chapman smelter at San Francisco.

QUICKSILVER.—The price of Spanish quicksilver continues to rise, and is now £17. 10s. per flask.

PLATINUM.—185s. per oz., nominal.

BISMUTH.—10s. per lb.

COBALT.—7s. 6d. per lb.

CADMIUM.—7s. 9d. per lb.

ALUMINIUM.—The price is advancing, and the quotation is £140 per ton or more. The metal is sought as a substitute in different ways for both copper and zinc.

CHROMIUM.—Chrome ore, averaging 50%, is quoted at 110s. per unit delivered in England. In our last issue the word 'ton' was wrongly substituted for 'unit.'

IRON.—No great variation in price of pig iron is recorded, No. 3 Cleveland standing at 67s. per ton, and Cumberland hematite 95s. Rubio (Spanish) ore is quoted at 25s. 6d. delivered.

NICKEL.—£210 per ton.

MOLYBDENUM.—Little business in molybdenite is reported, and the quotation remains at 115s. per unit for 90% MoS_2. Ferro-molybdenum, 18s. per lb. of molybdenum contained.

TUNGSTEN.—The price of wolfram continues to advance, 50s. per unit being quoted for 70% pure. The price of scheelite is about the same. Ferro-tungsten, 6s. per lb. of tungsten contained. Tungsten metal 6s. per lb.

MANGANESE.—Little or no new business is done in manganese ores. Indian ores, containing 50%, are nominally quoted at 1s. 8d. per unit, delivered at English ports.

QUOTATIONS

of leading mining shares on the London Market.
Shares are £1 par value except where otherwise noted.
Quotations are given in shillings.

GOLD, SILVER, DIAMONDS:	July 1 1914	June 1 1915	July 1 1915
Rand:			
Bantjes	14	10	9
Brakpan	51	52	54
Central Mining (£12)	160	135	130
Cinderella	6	4	3
City & Suburban (£4)	52	46	47
City Deep	66	63	60
Consolidated Gold Fields	43	30	24
Consolidated Langlaagte	35	35	37
Consolidated Main Reef	18	19	19
Crown Mines (10s.)	120	86	82
D. Roodepoort Deep	17	18	17
East Rand Proprietary	33	31	26
Ferreira Deep	47	46	44
Geduld	23	31	28
Geldenhuis Deep	26	21	21
Gov't Gold Mining Areas	23	21	21
Heriot	55	65	64
Jupiter	5	6	6
Kleinfontein	24	25	23
Knight Central	8	9	6
Knight's Deep	35	25	29
Langlaagte Estates	20	18	19
Luipaard's Vlei	10	8	7
Main Reef West	7	7	7
Meyer & Charlton	115	107	109
Modderfontein B	89	100	101
Modder Deep	58	86	84
Modderfontein, New (£4)	263	294	290
Nourse	27	26	22
Rand Mines (5s.)	120	98	92
Randfontein Central	17	13	11
Robinson (£5)	57	34	35
Robinson Deep	33	26	25
Rose Deep	43	36	37
Simmer & Jack	12	8	11
Simmer Deep	1	1	1
Springs	11	23	21
Van Ryn	67	60	61
Van Ryn Deep	47	53	51
Village Deep	40	37	36
Village Main Reef	40	32	30
Witwatersrand (Knight's)	71	62	65
Witwatersrand Deep	48	34	33
Wolhuter	14	14	11
Rhodesia:			
Cam & Motor	19	15	14
Chartered	17	11	9
Eileen Alannah	11	9	6
Eldorado	18	14	14
Enterprise	9	6	5
Falcon	14	11	8
Giant	14	7	7
Globe & Phœnix (5s.)	32	27	27
Lonely Reef	27	22	23
Shamva	46	37	37
Wanderer (5s.)	3	1	1
Willoughby's (10s.)	7	6	5
Others in South Africa:			
De Beers Deferred (£2 10s.)	330	237	207
Glynn's Lydenburg	11	10	10
Jagersfontein	78	57	52
Premier Diamond Defer'd (2s. 6d.)	152	97	95
Sheba (5s.)	4	4	4
Transvaal Gold Mining Estates	37	36	36
West Africa:			
Abbontiakoon (10s.)	8	9	8
Abosso	14	9	7
Ashanti (4s.)	16	15	15
Broomassie (10s.)	2	1	1
Prestea Block A	15	12	11
Taquah	15	14	15
West Australia:			
Associated Gold Mines	7	5	5
Associated Northern Blocks	7	4	4
Bullfinch	6	6	6
Golden Horse-Shoe (£5)	43	46	47
Great Boulder Proprietary (2s.)	14	16	14
Great Boulder Perseverance	2	1	1
Great Fingall	9	5	3
Ivanhoe (£5)	50	44	47
Kalgurli	36	36	34
Sons of Gwalia	23	17	16
Yuanmi	3	2	2

GOLD, SILVER, *cont.*	July 1 1914	June 1 1915	July 1 1915
Others in Australasia:			
Blackwater	16	15	15
Consolidated Gold Fields of N.Z.	13	12	11
Mount Boppy	10	12	10
Mount Morgan	52	46	49
Progress	10	7	7
Talisman	33	22	21
Waihi	42	40	39
Waihi Grand Junction	25	23	23
America:			
Alaska Treadwell (£5)	162	144	147
Buena Tierra	15	13	13
Butters Salvador	20	15	15
Camp Bird	9	5	5
Canadian Mining	—	9	8
Casey Cobalt	13	11	7
El Oro	14	7	7
Esperanza	15	7	8
Kirkland Lake Proprietary	74	30	27
Mexico Mines of El Oro	97	72	67
Oroville Dredging	10	12	14
St. John del Rey	15	15	15
Santa Gertrudis	11	7	7
Tomboy	22	24	22
Tough-Oakes	28	9	8
Russia:			
Lena Goldfields	43	36	35
Orsk Priority	7	8	8
India:			
Champion Reef (2s. 6d.)	11	11	11
Mysore (10s.)	93	85	86
Nundydroog (10s.)	27	25	25
Ooregum (10s.)	23	25	25

COPPER:

Anaconda (£5)	126	131	149
Cape Copper (£2)	60	62	62
Chillagoe (10s.)	1	½	½
Cordoba (5s.)	6	4	3
Great Cobar (£5)	3	2	2
Great Fitzroy (5s.)	½	¼	¼
Hampden Cloncurry	27	25	33
Kyshtim	55	47	42
Messina (5s.)	15	10	14
Mount Elliott (£5)	55	59	65
Mount Lyell	23	25	25
Rio Tinto (£5)	1355	1192	1170
Sissert	25	21	19
South American Copper (2s.)	22	15	15
Spassky	52	51	42
Tanalyk	78	47	41
Tanganyika	40	26	27

LEAD-ZINC:

Broken Hill:			
Amalgamated Zinc	28	20	26
British Broken Hill	36	24	23
Broken Hill Proprietary (8s.)	36	42	45
Broken Hill Block 10 (£10)	32	22	21
Broken Hill North	52	42	42
Broken Hill South	175	145	145
Sulphide Corporation (15s.)	26	19	20
Zinc Corporation (10s.)	19	14	14
Asia:			
Burma Corporation	28	37	38
Irtysh Corporation	—	36	35
Russian Mining	31	18	15
Russo-Asiatic	151	100	87

TIN:

Nigeria:			
Bisichi	8	6	6
Jos (5s.)	5	4	4
Kaduna (5s.)	15	15	15
Naraguta	17	16	15
N. Nigeria Bauchi (10s.)	3	2	2
Rayfield	5	4	4
Ropp (4s.)	100	17*	16*
Other Countries:			
Aramayo Francke	31	27	27
Briseis	5	5	5
Cornwall Tailings	17	15	15
Dolcoath	11	7	7
Geevor (10s.)	5	4	4
Gopeng	27	30	29
Mawchi	20	2	4
Pahang Consolidated (5s.)	7	7	7
Renong Dredging	36	21	20
Tekka	55	60	60
Tronoh	26	30	30

* Denomination of shares recently changed from £1 to 4s.

PRECIS OF TECHNOLOGY

[*Copies of the original papers and articles mentioned under this heading can be obtained on application to the Technical Bookshop, Salisbury House, London E.C., the book department of The Mining Magazine.*]

Rhodesian Diamond Deposits.—Three years ago a subsidiary of the British South Africa Co., called the South African Options Syndicate, undertook the exploitation of diamondiferous rocks in the Bembesi and Shangani valleys and in the Somabula forest, in Southern Rhodesia. The results have so far been indifferent. Some account of the deposits was given in Percy A. Wagner's book. Further information is now published in the Annual Report, for 1914, of the Rhodesian Geological Survey, based on an examination of the two districts made by A. E. V. Zealley. As regards the first-named district, occurrences of kimberlite, or blue ground, are found in a tract of country about 35 miles long, stretching from near Lochard in a northeasterly direction to a point between the Shangani river, and its tributary, the Vungu. The area is roughly 40 miles northwest of Gwelo and 60 miles northeast of Bulawayo. Six bodies of kimberlite have been examined for diamonds, and three other bodies have been noted but not examined. The kimberlite fills fissures, which in some cases have been enlarged by volcanic outbursts, and near the surface it is oxidized into 'yellow ground.' Two of the bodies have been proved to contain diamonds. These are of good quality, but are small and do not exist in profitable quantity. The prospectors found the kimberlite bodies by following ilmenite and garnet occurring in the streams and soil. With one exception the kimberlite is covered by deep soil and bush, which make prospecting difficult. There is every reason to expect that other pipes or fissures will be found and that some may be profitable.

The Somabula district lies between the Shangani and Gwelo rivers and is nearer to Gwelo than the Shangani-Vungu district. The Somabula series of diamond-bearing beds has been traced by Mr. Zealley for about 70 miles in a northwesterly direction from Willoughby's Halt. The series may be divided into two groups, the lower one consisting of coarse sand, locally cemented, mudstone, and gravel, and the upper one of red and white sands, and gravel with agates. The gravel of the lower group is well rounded, while in the upper gravel the pebbles are less rolled, and comprise varieties not found in the lower, such as agate, silicified sandstone, and slightly water-worn pieces of fossil wood. The lower series is found only at the southeast end, and over the rest of the area the upper series rests directly on the granite. The granite floor has been completely decomposed, into what is known locally as pot-clay. The series is presumably younger than the rocks of the Karroo system, which is of Permo-Carboniferous age, and as the gravels run up on the main divide of the country it is clear that they are older than the present river system. The presence of pot-holes in the granite floor, and the lenticular character and oblique bedding of the gravels show that the lower group has been deposited by some ancient river. The series is remarkable for containing not only the diamond but also a rich and varied assemblage of gem-stones and also gold. The chief gem-stones are chrysoberyl, cat's eye, and topaz, the last-named occurring in the white and blue varieties. The stones are found chiefly in the bottom layers of gravel resting on the granite, whether the gravel belongs to the upper or the lower group. The best indicator is the abundance of dark water-worn crystals of staurolite, locally known as 'blacks.' The diamonds have also worked downward for a few inches into the decomposed granite. The source of the diamonds is a matter of speculation, and it is supposed by Mr. Zealley and by P. A. Wagner that they came from the southeast along the ancient river already mentioned. The absence of ilmenite and chrome diopside makes it unlikely that a kimberlite pipe exists under the gravels or in their neighbourhood. During 1914 there were thirty or forty diggers at work. The deposits are not amenable to development on a large scale, for in most places they are covered with deep overburden, and there is scant water-supply. As the diamonds are found in what was an ancient river bed, it is probable that richer leads may be found, and the prospector is recommended to keep this point in view. Gold is found in the same gravel and the coarser grains and nuggets are recovered with the diamonds in washing.

Milling at Broken Hill.—The *Mining and Engineering Review* for May contains an article on 'Broken Hill Milling Practice,' discussing in detail the methods of crushing and concentration at the various lead-zinc-silver mines at Broken Hill. The author deals solely with the lead-mill practice, and does not refer to the beneficiation of the zinc tailing by flotation. The contents of the Broken Hill lode vary greatly in different parts, both as regards the nature and distribution of the gangue minerals and in connection with the intimacy of the mixture of the sulphides, so that it has been impossible to adopt a standard method of treatment. This fact explains the apparent anomaly of variations in practice over a comparatively short lode. The ore is first sent to gyratory crushers, and the tendency recently has been to crush finer in these machines, the present size produced being about 1½ in. Where the amount of rhodonite, which is extremely hard, is large, this policy of finer crushing is particularly advantageous. The crushed ore is delivered to slotted shaking-screens which pass material smaller than 3 mm., or 4 mm if the ore is rather softer. The undersize goes to jigs, and the oversize to rolls. Cornish slow-speed rolls are used, 36 in. long and 18 in. diameter, with a speed of 15 to 25 revolutions per minute. They are run fairly open, with a large return of oversize to the screen. No lateral motion is given, as the shaking screen distributes the feed uniformly and the wear is even. The material having been reduced to pass 3 mm. screens, is sent either to hydraulic classifiers or to finer screens, so as to remove the fine sand and slime, the coarser material being sent to the jigs. The Hancock jig has of recent years been superseded by the May jig. At most of the mines no attempt is made to produce a worthless tailing in the jigs, the function of the jigs being solely to recover the coarser galena, the material then passing to the re-grinding machines. This method is exemplified at the Central, South, Proprietary, and Junction North mills. According to other practice, as at the North mine, two sets of jigs are used with five hutches in each set. In the primary jigs, no worthless tailing is made, but all the tailing is sent to be re-ground for the tables. In the first two hutches, lead concentrate is collected, in No. 3 middling which is returned, in No. 4 middling which is re-ground and sent to the second set of jigs, in No. 5 tailing which is sent to be re-ground for the tables. The re-grinding machines originally employed were pans, and the step-grinding system was employed. Tube-mills have of late years been adopted, and crushing can be better regulated by their use, besides the cost of crushing being less. The reduction in size in re-grinding is arranged so that of the product not more than 5 to 15% remains on a 40-mesh screen. The usual size of the tube-mills is 10 ft. by 5 ft., working at 28 r.p.m. Those mounted on trunnions are preferred. Cast-iron liners are used, the size being 20 by 13 by 1½ in. In some cases, 3 by 2 in. longitudinal bars lift the pebbles to the required height; in other cases the ridges form part of the liner plates. The life of liners is 2 years when crushing quartz, and 9 months when working on rhodonite. The pebbles are usually kept at 2 in. below the centre at the feed end and 4 in. below at the discharge. The load of pebbles is approximately 4 tons. A coarse screen is fixed in the discharge end to prevent pebbles escaping. Scoop feeds have lately been tried with satisfactory results. The usual practice has hitherto been to pass the feed into the tube-mill through a cast-iron bend fitted to the bottom of the classifier. Pebbles are fed by hand through the manhole once a day. The consumption is low, being from 1½ to 2 lb. per ton of material treated. The re-ground material is fed directly upon tables without classification, the slime flowing over the top end of the tables. Both riffles and grooves are employed, and their relative merits are still under discussion. Improvements have recently been made in riffle tables with the object of spreading the lead at the top end. Instead of riffles being cut off diagonally across the table, some of the riffles are extended at the far corner of the table to its full length, the remainder being cut off in the form of a curve. The middlings from the first set of tables are treated on a second set of tables, and the middlings formed on the latter returned to their own feed. At various mills different arrangements are made for producing a barren quartz tailing separate from the zinc tailing. Where much calcite is present, a barren tailing is always made. The slime is treated on Wilfley or Card slime-tables, or on Weir-Meredith vanners. The latter has been gradually displacing other types of vanners. It consists of a wooden table upon which the belt travels, a film of water between the belt and the wood facilitating the travel. The belt holds the concentrate better than when it is supported by rollers. As a general rule, the slime tables and vanners make lead concentrate, middling, and tailing, and the middling is returned to the same table. The slime tailing is de-watered by means of Dorr thickeners, and sent to the dump to await treatment by flotation. As the slime product is of greater value owing to selective flotation, more care is now taken in removing it from the various zinc and tailing products; and, incidentally, as the slime is higher in lead than the coarser products, a higher grade in zinc is produced from the coarser products.

Platinum in Southern Nevada.—In *Bulletin* 620-A of the United States Geological Survey (printed in abstract in the *Mining and Scientific Press* for June 5), Adolf Knopf presents the results of his examination of the Boss mine, near Good Springs, Nevada, made last October. The Boss mine came into prominence at that time through shipment of a small lot of ore containing 111 oz. gold, 99 oz. platinum, and 16 oz. palladium. The mine is a small one worked unsuccessfully 30 years ago for copper. The gold was discovered in May 1914, and in September the presence of platinum in and with the gold was determined through the astuteness of H. K. Riddall, a local chemist. His findings were confirmed through assays made for the Geological Survey by Ledoux & Co. The platinum occurs in a bismuth-bearing variety of plumbojarosite (a hydrous sulphate of iron and lead) and in a fine grained silicious matrix associated with chrysocolla and limonite. It is one of the known primary occurrences of platinum of possible economic importance. The presence of platinum was not previously recognized because the plumbojarosite (worth as much as £300 per ton) is concentrated on panning with a black residue that might easily be confused with ordinary black sand. The ore occurs in Carboniferous limestone along a fissure zone. There are small quartz-monzonite and quartz-porphyry dikes in the neighbourhood, though none immediately at the mine. Mr. Knopf regards the ore in its present form as due to surface concentration and action of ferric sulphate solutions and galena, and considers that the primary orebody will be found to be a mixture of copper, iron, lead, and other sulphides. He imputes its origin to moderately heated waters, presumably related to the intrusion of the igneous rocks. The district is one best known for its output of lead and zinc.

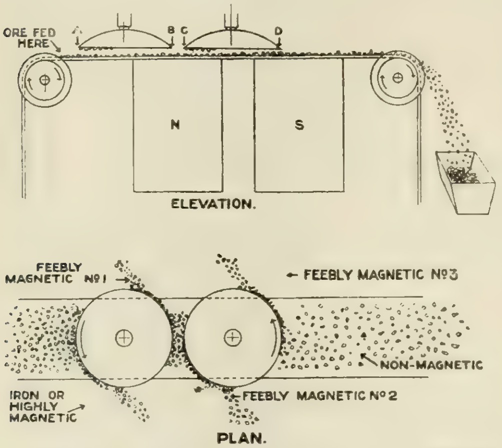
Coal in Spitzbergen.—The *Colliery Guardian* for May 14, 21, and 28 contains an article describing the geology of Spitzbergen and the coal-mining operations conducted in those islands. The article is based by a memoir by M. R. Berr published in *Annales des Mines*, Series 11, Vol. 5, part 3. The coal deposits found here are notable for two reasons. First, they are well within the Arctic Circle, extending from 77° to 81° North Latitude, and are thus much nearer the pole than the coal deposits discovered by Dr. Douglas Mawson in the Antarctic continent, which are no further south than 66°. Second, the deposits belong to three entirely different geological ages, the Lower Carboniferous, the Jurassic, and the Tertiary. Spitzbergen consists of three main islands, of which the largest, West Spitzbergen, affords the greatest opportunity for study and exploration, owing to the harbour facilities of Ice Fjord. The climate is not so rigorous as might be expected, and the islands are the least inhospitable of all the polar regions, this fact being due to the influence of the Gulf Stream. The temperature of the ground never rises to the melting point of ice, so that no water troubles have to be combated during mining. On the other hand, the accessibility of the harbour by water is confined to two months of the year, seriously limiting the delivery of the output of coal and communication with the rest of the world. The long winter night lasting for four months makes the country unattractive to labour. Coal was first discovered in Spitzbergen in 1870 by a Scotsman named Lamont, but it was not until 1905, when an English and an American company started operations, that any attempt was made to mine the deposits. Since then, several Swedish and Norwegian enterprises have been formed. For a long time, the political ownership of the islands and of the individual properties was in dispute, the islands being a no-man's-land, but in 1912 a joint commission was appointed to supervise the Norwegian, Swedish, and Russian communities.

The geology of Spitzbergen has been studied by Dr. Nathorst, of Upsala. The country has much the same characteristics as northern Europe, Iceland, and Greenland, and the inlets are all of the fjord type, having precipitous sides which continue downward below sea-level. The western and northeastern portions of West Spitzbergen are composed of Pre-Cambrian and Silurian rocks. On the northern side of Ice Fjord are Carboniferous and Permian rocks, and also Jurassic. The last-named are also found on the south side of the fjord between Sassen Bay and Advent Bay. Tertiary rocks are found along the south side, between Advent Bay and Green Bay. The Car-

Geological map of the Coal District around Ice Fjord in Spitzbergen.

boniferous, Jurassic, and Tertiary strata around the fjord all contain workable coal-seams. The most important of the mines is that on the southwest side of Advent Bay, opened by an American, Mr. Longyear, in 1905, and now worked by the Arctic Coal Co. The coal is of high calorific value, and contains only $3\frac{1}{2}$% water, 1·7% ash, and $1\frac{1}{2}$% sulphur, but it is friable and thus not suitable for coking, and it is smoky. It is in no way similar in character to the Tertiary lignites of Germany. The chief market is at Hammerfest, Norway, where it is sold to shipping companies and to the State railways. Another pioneer company was the Spitzbergen Coal & Trading Co., also formed in 1905, the capital being raised in England. This company worked the Jurassic deposits northeast of Advent Bay. The enterprise was unsuccessful, chiefly owing to the faulted nature of the strata. A third district worked within the last two or three years is at Mount Pyramid, at the head of Klaas Billen Bay. This enterprise is in the hands of Norwegian and Swedish ironmasters, and the coal belongs to the Lower Carboniferous. It is stated that the coal does not give a coke suitable for use in the blast-furnace. Many other enterprises are recorded in the article quoted. They have had various fortunes, and their prospects are in many cases promising. No doubt more will be heard of Spitzbergen coal in the future, for the deposits are extensive and easily worked, but the limiting of the export to two months of the year is a serious economic disadvantage.

Magnetic Separator.—The *Iron and Coal Trades Review* for May 28 contains a short notice of a new magnetic separator made by the Rapid Magnetting Machine Co., of Birmingham, for the purpose of separating or concentrating slightly magnetic minerals. The crushed ore or concentrate is fed upon a travelling belt, underneath which is a two-pole electromagnet. Over the belt are two revolving dome-shaped discs, wider than the belt, one *A B* in front of the first pole, and the other *C D* between the two poles, but nearer the first than the second pole. The edges of the discs are magnetized by induction, but



Diagrammatic sketch to illustrate the Rapid Magnetting Company's Separator.

the parts overhanging the belt being out of the field of the electromagnet lose their magnetism. The disc *A B* is less magnetized than *C D*, and the side *A* is less magnetized than the side *B*. Similarly the side *C* is less magnetized than the side *D*. As the material travels with the belt, the most highly magnetic portions are attracted to the edge of the disc at *A*, and as the disc revolves the adhering particles pass out of the magnetic field and fall into a receptacle. At *B*, *C*, and *D* other material in descending order of magnetic susceptibility is removed in similar fashion. Further information as to the practical nature of this machine is desirable.

Extraction of Mercury.—In our May issue we gave a précis of an article that appeared in the April *Bulletin* of the Canadian Mining Institute, describing a method invented by E. B. Thornhill for recovering mercury left in the tailing from the amalgamation-cyanidation process of treating high-grade silver ore at Cobalt. Mr. Thornhill contributes an article to the *Mining and Scientific Press* for June 5, describing the application of this process to the extraction of mercury from its ores. At the present time the metallurgy of mercury is troublesome and expensive, and much money is locked-up during the accumulation of the mercury in the condensers. Poisoning of the workmen is also a serious question. If a rapid wet method could be devised, great advantage would accrue to the producers. Mr. Thornhill's process consists of leaching the ore with a solution of sodium sulphide, and precipitating the mercury from the double sulphide thus formed by means of scrap aluminium in the presence of caustic soda. We refer our readers to the article in our May issue, mentioned above, for an account of the details of the reaction and cost of the process.

Mining Methods at Mount Lyell.—At the Tasmanian meeting of the Australasian Institute of Mining Engineers, R. M. Murray read a paper describing the mining methods adopted at Mount Lyell. The special feature is the open-stope system, adapted as the result of local experience. It is called rill-stoping, but would be more correctly described as arched back stoping, as the ground is so worked as to rely for support on the arching of the stope roof rather than on timbering. The method is in use both at the Mount Lyell and the North Lyell mines, but it is seen in its simplest form at Mount Lyell. The pyritic orebody at the Mount Lyell mine was worked by open-cut to No. 5 level at 450 ft. Underground operations are now being carried on for 250 ft. below this level. The orebody is cut at each level into suitable stoping sections, divided by pillars of solid ore 25 ft. thick, which are continuous in a vertical plane throughout the mine. There are two transverse pillars 100 ft. apart, and two longitudinal ones, also 100 ft. apart. Sill floor stoping is commenced from some convenient point of attack, and the ore taken out for a height of 12 ft., the back being left flat and temporarily supported by stacks where necessary. When the sill floor has been well advanced, a filling rise is put up from a central position to connect with the filling pass at the level above, and the construction of the galleries or haulage roads is commenced. These usually comprise one main gallery leading direct to the ore shaft, with cross galleries at right angles extending to the wall pillars. The galleries are constructed of square set timber, 7 ft. centre to centre, and 8 ft. 6 in. in height, the legs being specially large (2 ft. to 2 ft. 6 in) to provide good seating for the caps and struts. The sets are laid down on heavy round lagging 15 ft. long and 8 to 10 in. in diameter to facilitate picking up the level subsequently. They are temporarily stayed in position by crown trimming. They are laced up on the outer sides with round lagging or sawn timber and covered with a double layer of heavy round lagging laid transversely. The floors of the panels formed between the cross galleries are also covered with heavy round lagging, laid to break joint, and the portion of the stope around the central filling rise is then ready to receive filling. The sides and tops of the galleries having been lined with old coke bags to prevent fine material escaping, filling is run in, and allowed to fill as much of the nearest panels as possible, and also to support and cover the adjoining gallery timbers. Everything is thus in readiness for the first overhead stope to be commenced. This is undertaken from the rise, working outward and downward in all directions. Filling is then again run in, covering the further portions of the sill floors and timbers, and forming a cone below the rise from which to begin further breaking operations. When several small stopes have been taken off in this manner, a fairly large dome-shaped chamber, containing a corresponding cone of filling has been formed, and the stope is then well opened-up for vigorous ore-breaking, the domed roof eventually covering the whole of the sill floor area, and having for its abutments the pillars or footwall. The multiplicity and placing of the ore passes are special features of the system. Their construction is taken in hand immediately prior to each of the filling operations. They are built of 10 in. round or split timber, joggled at the end, and measure 6 ft. by 4 ft. They are placed on each side of the galleries, at such distances that their centres are about 15 ft. apart horizontally, the close space reducing the handling of the ore in the stope to a minimum, and also rendering the wear on the timbers much less than would be the case were all the ore broken handled in fewer passes. As the height of the stope increases, however, and the slope of the filling becomes greater, the ore is readily handled over greater distances, and some of the passes are then discarded. Under favourable conditions about 75% of the filling required to fill a stope will run into position by gravity. It is delivered direct from waggons into one of the numerous passes, water being simultaneously led into the pass, so that when it reaches its destination it has a consistency similar to that of rather wet concrete, and sets into a solid cement. In the general work of ore-breaking, 3 in. machine-drills are used, each being operated by one man and two machines working in close proximity, so that the drillmen can assist each other in lifting them, and in other ways. Commencing at the rise and working outward and downward, the holes drilled are roughly parallel to the slope of the filling, and are all consequently down or water holes, which conduces to leaving a clean back, and also minimizes dust. A water jet is used with each machine. The average amount of ore broken per shift per machine is 25 tons; the average amount produced per man per shift, counting all hands engaged on a stope, 10½ tons. The amount of ore spalled and shovelled into passes per man per shift is 25 tons.

Output of Zinc in United States.—The position of the zinc market, with the United States as practically the only source of supply of zinc for the Allies, gives especial interest to the statistics prepared by C. E. Siebenthal for the United States Geological Survey. These figures relate only to zinc obtained from ores, that is to say 'primary' zinc, and not any 'secondary' metal recovered from scrap.

OUTPUT OF ZINC BY STATES.

Apportioned according to Source of Ore.

	1913 Tons	1914 Tons
Arizona	4,675	3,905
Arkansas	478	670
California	1,012	159
Colorado	58,113	41,746
Idaho	10,190	22,720
Illinois	1,345	1,833
Kansas	9,956	10,634
Kentucky	172	147
Missouri	129,018	114,019
Montana	35,604	55,986
Nevada	5,828	6,041
New Jersey	24,247	27,731
New Mexico	3,765	4,345
North Carolina	152	
Oklahoma	6,397	9,449
Tennessee	2,635	6,122
Texas	303	156
Utah	9,503	6,818
Virginia	116	20
Wisconsin	33,743	30,914
Total	337,252	343,418

ZINC PRODUCED FROM IMPORTED ORES.

	1913	1914
Canada	1,424	4,538
Mexico	6 205	5,093
Europe	1,175	
Siberia	620	
Total	9,424	9,631
Total of Domestic and Foreign	346,676	353,049

TOTAL PRODUCTION.

Arranged according to Smelters' Output.

	1913	1914
Illinois	106,654	127,946
Kansas	74,106	44,510
Oklahoma	83,214	91,367
Other States	82,702	82,226
Total	346,676	353,049

NAMES OF ACTIVE SMELTING COMPANIES WITH NUMBER OF RETORTS AT END OF 1914.

	Retorts
COLORADO	
United States Zinc Co., Pueblo	1,920
ILLINOIS:	
American Zinc Co. of Illinois, Hillsboro	4,000
Collinsville Zinc Sm. Co., Collinsville	1,536
Granby Mining & Sm. Co., East St. Louis	
Hegeler Zinc Co., Danville	1,800
Illinois Zinc Co., Peru	4,640
Matthiesson & Hegeler Zinc Co., La Salle	5,256
Missouri Zinc Co., Beckemeyer	192
Mineral Point Zinc Co., Depue	9,080
National Zinc Co., Springfield	3,200
Lanyon Zinc & Acid Co., Hillsboro	1,840
Sandoval Zinc Co., Sandoval	996
Total	32,540
KANSAS:	
Altoona Zinc Sm. Co., Altoona	3,960
American Zinc, Lead & Sm. Co., Caney	3,648
American Zinc, Lead & Sm. Co., Dearing	3,840
Chanute Zinc Co., Chanute	1,280
Edgar Zinc Co., Cherryvale	4,800
Granby Mining & Sm. Co., Neodesha	2,560
La Harpe Spelter Co., La Harpe	1,856
Pittsburg Zinc Co., Pittsburg	910
Prime Western Spelter Co., Gas	4,768
Total	27,5[illegible]2
MISSOURI:	
Edgar Zinc Co., St. Louis	1,100
OKLAHOMA:	
Bartlesville Zinc Co., Bartlesville	5,184
Bartlesville Zinc Co., Collinsville	8,064
Lanyon-Starr Sm Co., Bartlesville	3,456
National Zinc Co., Bartlesville	4,260
Tulsa Fuel & Manufg. Co., Collinsville	6,232
Tulsa Spelter Co., Sand Springs	2,400
Total	29,596
PENNSYLVANIA:	
American Zinc & Chem. Co., Langeloth	880
New Jersey Zinc Co., Palmerton	5,760
Total	6,640
WEST VIRGINIA:	
Clarksburg Zinc Co., Clarksburg	1,824
Grasselli Chem. Co., Clarksburg	5,760
Grasselli Chem. Co., Meadowbrook	6,912
Total	14,4[illegible]6
Total for all States	113,824

PLANTS WITH SPECIAL RETORTS.

Michael Hayman & Co., Buffalo, N.Y.	12
Trenton Sm. & Ref. Co., Trenton, N.J.	40
William Cramp & Sons Co., Philadelphia, Pa	24

The Collinsville, Chanute, and Pittsburg company's furnaces were idle in 1914. The above table includes companies treating dross as well as ore, so that the average capacity of the retort cannot be calculated from their number and the output of 'primary' zinc.

CURRENT LITERATURE

[Copies of the original papers and articles mentioned under this heading can be obtained on application to the Technical Bookshop, Salisbury House, London E.C., the book department of The Mining Magazine.

Mining at Ray Consolidated.—The June issue of the *Bulletin* of the American Institute of Mining Engineers contains a valuable paper by L. A. Blackner describing the methods of mining at the Ray Consolidated copper mine, Arizona.

Winding Drums.—At the June meeting of the North of England Institute of Mining and Mechanical Engineers, H. W. G. Halbaum read a paper discussing the various types of winding drums and their applications. The paper is popular rather than technical or mathematical.

Ventilation at Cripple Creek.—In the *Engineering and Mining Journal* for June 5, S. A. Worcester gives further information relating to the pressure system of ventilation adopted at certain Cripple Creek mines, following his article in the issue of January 17, 1914.

Concrete Arches for Mines. — The *Iron & Coal Trades Review* for July 2 contains a description of Peter Lind & Co.'s system of building arches and roofs from interlocking blocks of ferro-concrete. It can also be used for shaft linings. This system is on show at the company's works at Willesden, near London.

Electric Hoists.—The *Iron & Coal Trades Review* for July 2 describes an underground electric hoist made by Holman Brothers, of Camborne, for the Witwatersrand Deep mine, in the Transvaal.

Fire Fighting Methods at the Mountain View Mine.—In the *Bulletin* of the American Institute of Mining Engineers for June, C. L. Berrien gives details of the work of extinguishing a large underground fire. The burning ground was isolated and flooded by means of hanging wall drifts from which holes were drilled to the burning stopes.

American Coal-Dust Investigations.—At the meeting of the Institution of Mining Engineers held on June 3, George S. Rice, chief mining engineer of the United States Bureau of Mines, presented an elaborate report upon work done at the Bruceton Experimental Mine in Pennsylvania. His results confirm the value of stone-dust in preventing explosions, but indicate the necessity of a higher ratio, at least with certain coals, that European experience had dictated.

Unloading Chilean Iron Ore.—The *Mining and Engineering World* for June 5 describes the Hulett unloader building at Constable Hook to operate in connection with 15,000 ton steamers of 'Lake' type, now being constructed for use of the Bethlehem Steel Co. in bringing Tofo ore to the United States.

Boring and Drilling an Oilfield.—Paul Dvorkovitz presented to the June meeting of the Institution of Mining Engineers a general review and comparison of the Pennsylvania cable, Canadian pole, Russian free-fall, and hydraulic rotary systems of drilling.

Callow Flotation Process. — In the *Mining and Scientific Press* for May 29, J. M. Callow contributes information on many points of detail with regard to his flotation process of concentration. The principle of this process was described in our issue of August 1914.

Flotation at Butte. — The June *Bulletin* of the American Institute of Mining Engineers contains a paper by Theodore Simmons describing the flotation plant of the Timber Butte Milling Co., which treats the complex sulphide ore at W. A. Clark's Elm Orlu mine, in Montana. A short account of the plant was given in our issue of July last year.

Concentrating Magnetite Ore.—In the *Engineering and Mining Journal* for June 5, B. B. Hood describes the concentrating methods at the magnetite deposits at Moose Mountain, Sellwood, Ontario.

Theory of Tube-Milling.—At the March meeting of the Chemical, Metallurgical, and Mining Society of South Africa, H. A. White presented a paper on the theory of tube-milling, discussing in detail most of the main features of the tube-mill and the practice.

Metallurgy of Alluvial Mining.—In the *Mining and Scientific Press* for May 29 and June 5, John M Nicol writes suggesting improved methods of recovering gold from gravel, particularly fine gold and gold that is not free. He describes devices for continuously cleaning the riffles, de-watering the gravel, etc.

Mining in Morocco.—The Regulations constituting the decree of January 19, 1914, are printed in full in *Annales des Mines*, No. 3, for 1914, forming pages 234-270 of tome V.

Rosebery Mines.—In the *Australian Mining Standard* for April 22, Hartwell Conder gave some particulars of the complex sulphide ores of the Hercules, Primrose, and Tasmanian Copper mines on the west coast of Tasmania, recently acquired by the Mount Lyell company.

Geology of Meekatharra.—The *Monthly Journal* of the Chamber of Mines of Western Australia contains a paper by E. de C. Clarke on the geology of Meekatharra mining district in the Murchison goldfield.

Tin in Queensland. — In the *Queensland Government Mining Journal* for April, E. C. Saint-Smith describes the tin-mining operations at China camp on the Bloomfield river, south of the port of Ayton, North Queensland.

Mining in Burma.—At the June meeting of the North of England Institute of Mining and Mechanical Engineers, C. W. Chater presented a paper reviewing the present mining operations in Burma, including mining for lead, zinc, wolfram, tin, gold, rubies, and jade.

Origin of Coal.—In the May issue of the *Journal of Geology*, Edward C. Jeffrey, of Harvard University, describes his investigations by means of the microscope into the constitution and origin of coal. The author makes no mention of James Lomax's work on these lines, described in our issue of March 1912.

Glaciers of the Rocky Mountains.—In the *Canadian Mining Journal* for June 15, A. P. Coleman writes on the glaciers of the Rockies and Selkirks; a general descriptive article with excellent illustrations.

Royalties at Cobalt. — In the *Canadian Mining Journal* for June 15, A. A. Cole explains the origin and reasons for royalties paid by certain mines at Cobalt, Ontario.

NEW BOOKS

Petroleum Technologist's Pocket-Book. By Sir Boverton Redwood and Arthur W. Eastlake. Pocket size, leather, 460 pages, illustrated. London: Charles Griffin & Co. Price 8s. 6d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

This is a first attempt at a *vade mecum* for oil men comparable to Kent's and other well known handbooks used by engineers in other lines. It is a useful book despite its awkward shape, though it might have been improved by the addition of cost data, to accommodate which the tables of analyses might have been condensed and some perhaps eliminated. Such books are necessarily in most part compiled, and their value would be increased if much of the material were dated. References to further sources of information might well have been made more plentiful in the body of the text, and in view of the large amount of excellent technical data available in government and state reports, which can be consulted at numerous libraries, references to them as sources would have been helpful. While it is true that only books published by regular firms are ordinarily available for quick purchase, the engineer called to examine a new field usually has a few days for work in some library before he sails, and specific references to sources would be helpful. In so many tables, a few errors are fated to get past the proof reader. We note on p. 162, the specific gravity of Pennsylvania and West Virginia gas being given as 1·624. Such errors, however, are few, and the 'Pocket-Book' will be a ready help to many an engineer.

Practical Oil Geology. By Dorsey Hager. Cloth, limp, octavo, 150 pages, illustrated. New York: McGraw-Hill Book Co. Price 8s. 4d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

This is an excellent little book on the application of geology to oilfield problems, somewhat similar in scope to E. H. Cunningham Craig's 'Oil Finding,' but written from the American point of view. The author has had extended experience in the California fields especially, and is engaged in active practice as a consulting geologist in Western North America. The book is concise but clear, and illustrated with numerous sketches. It includes working diagrams and tables, and such general matter as is appropriate to the main purpose. The various chapters cover the origin and properties of petroleum, stratigraphy and structure as relates to oil, methods of prospecting and mapping, locating drill-holes, relations of geology to drilling, applications of geology to development of properties, a study of water problems, and some especial cautions. There are not many books on petroleum and this little volume will fill a gap in many a working library.

Surface Tension and Surface Energy, and their Influence on Chemical Phenomena. By R. S. Willows and E. Hatschek. Cloth, small octavo, 80 pages. London: J. & A. Churchill. Price 2s. 6d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

The principle of surface tension comes within the range of subjects the study of which is necessary for the modern mining man and metallurgist. For instance it forms the basis of flotation. Then the physical action of substances in an extremely fine state of division, usually called the colloidal state, comes within the scope of the metallurgical and geological chemist, and in the domain of wet metallurgy, adsorption explains many mysteries with regard to the disappearance of solvents and metal-bearing salts. The book now offered gives in a concise manner an outline of the principles underlying the application of surface tension to the explanation of many interesting phenomena.

Mechanical Drawing: with Special Reference to the Needs of Mining Students. By Joseph Husband. Quarto, paper covers, 84 pages, with many illustrations. London: Edward Arnold. Price 3s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

The author is head of the civil engineering department in the University of Sheffield, and the course of instruction in drawing embodied in the book deals particularly with machinery and details familiar to students of colliery engineering.

Introduction to Mining Science. By John B. Coppock and G. A. Lodge. Cloth, small octavo, 220 pages, illustrated. London: Longmans, Green & Co. Price 2s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

This little handbook is intended to instil into the minds of workers in mines the necessity for regarding all problems of underground safety in an intelligent way. It is cleverly and interestingly written, so that though intended primarily for the beginner and even the dullard, it contains so many novel presentations of well known facts that it may convey many a useful hint to the most seasoned individual. A specialty is made of the multifarious ways in which an underground fire can be started, and all through the book instances are given of methods for detecting and preventing such outbreaks. The various chapters deal with the composition of mine air, the production of air currents, methods of producing light and heat, diffusion of gases, the principle of the safety lamp, the nature and origin of coal. The subject matter does not include the mechanical aspect of mining dangers, such as accidents with machinery or falls of roof, and by confining the scope within the narrower limits, the authors have not been hampered by considerations of space and have been able to make their attack complete. Both in substance and method of presentation the book is excellent.

Laboratory Work for Coal-Mining Students. By J. Sim and A. M. Wylie. Cloth, small octavo, 140 pages. London: Edward Arnold. Price 2s. 6d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

This little book contains in a convenient form the chief and most reliable of the methods of testing coal, coke, oil, and mine gases. In various parts of the world widely divergent methods of reporting fixed carbon, volatile constituents, ash, sulphur, calorific value, etc., are employed, and a comparison of results often gives rise to misleading conclusions. The authors have taken a step toward the standardization of methods, and the influence of their book is all for good.

Brazil in 1913. By J. C. Oakenfull. Cloth limp, small octavo, 610 pages, illustrated. Frome, Somerset: Butler & Tanner. Price 7s. 6d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

This is the fifth issue of a year-book that gives particulars of the material resources of Brazil. It differs from the usual books of this class, in that it consists, not of dry-as-dust tables of statistics, but of descriptions of the geography, ethnology, flora and fauna, and mineral resources, written racily with a strain of human interest. A large amount of the information has been collected at first hand, and the author knows his country. He is quite up-to-date with regard to the gold mining operations in Minas Geraes, a fact that encourages our confidence in other parts of the book. To those intending to go to Brazil, or having interests in that country, the volume will prove valuable.

The Canadian Mining Manual. Edited by Reginald E. Hore. Toronto: Mines Publishing Co. Cloth, octavo, 273 pages, illustrated. Price 8s. 6d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

The 'Canadian Mining Manual' was founded by the late B. T. A. Bell, and published by him up to the time of his death. It has fallen into capable hands in passing to the editor of the *Canadian Mining Journal*, and in its new and revised form will prove an indispensable handbook for all interested in mines in Canada. Following a general account of mining in the Dominion, arranged by products and by provinces, 732 mining companies are listed alphabetically. While the information given about the various companies is unequal and there are many instances where it is inadequate, the total is vastly more than has been previously accessible in convenient reference form. Doubtless in succeeding editions of the work the gaps will be filled. As it stands, the manual is the only one available, and it is extremely serviceable.

COMPANY REPORTS

Zinc Corporation.—This company was formed by Bewick, Moreing & Co. in 1905 to apply the flotation process to dumps of zinc tailing at Broken Hill. After trials and uses of various systems, the Minerals Separation method was adopted in 1910. In 1911 the South Blocks mine was acquired, and in 1914 an interest in Barrier South, formerly the South Extended, was purchased. H. C. Hoover and T. J. Hoover are the leading spirits of this enterprise. The report for the year 1914 shows that after the outbreak of war the amount of lead concentrate sent to the Broken Hill Proprietary was reduced, and that the delivery of zinc concentrate to German buyers was stopped. Attempts to induce the English law courts to give a judgment as to the possibility of cancelling the German contract proved futile. Action on the part of the Commonwealth Government to legalize the cancellation of contracts with enemy aliens is expected to come to the help of all Australian metal producers, though, as the corporation is registered in England and not in Australia, the advantage of such legislation is not clear in this particular case. For this reason it is impossible to smelt the accumulated zinc concentrate or to continue production. Thus the activity of the corporation is crippled and the supply of the zinc so much needed by the Allies is curtailed. The corporation also suffers by its inability to collect payment for concentrate delivered to the German buyers. Suit has been entered in the Australian courts to recover £41,920 from Aron Hirsch und Sohn for concentrate delivered before the outbreak of war. The finances were affected by the impossibility, during the moratorium, of calling-in money on loan, and temporary difficulties were thereby caused in connection with the payment for the interest in Barrier South and with the distribution of dividend on the preference shares. The position has since improved. More recently the corporation has taken a £100,000 participation in the new company formed to work the Broken Hill Proprietary's smelter at Port Pirie, and the funds are to be obtained by loans against profits. During the year 1914, the lead mill treated 141,667 tons of ore averaging 14·4% lead, 9·3% zinc, and 2·6 oz. silver per ton, for a yield of 26,567 tons of lead concentrate averaging 64·6% lead, 6·45% zinc, and 9·2 oz. silver, together with 34,317 tons of zinc tailing averaging 15·8% zinc, 4·9% lead, and 1·6 oz. silver. At the zinc plant, 221,620 tons of zinc tailing was treated averaging 13·68% zinc, 5·93% lead, and 6·42 oz. silver. Of this amount, 169,180 tons was taken from the purchased dumps, and the rest came from the corporation's lead mill, and from the British and Junction mines. The yield of flotation concentrate was 63,300 tons, averaging 43·96% zinc, 13% lead, and 13·91 oz. silver. This was re-treated, the coarser parts on tables and the finer by the Horwood process, for the purpose of removing some of the lead, the final products being: 48,325 tons of table zinc concentrate, averaging 46·77% zinc, 7·64% lead, and 10·58 oz. silver; 3986 tons of Horwood zinc concentrate, averaging 48·17% zinc, 6·47% lead, and 15·16 oz. silver; 7469 tons of table lead concentrate, averaging 54·56% lead, 15·69% zinc, and 32·84 oz. silver; and 1688 tons of Horwood lead concentrate, averaging 35·48% lead, 14·63% zinc, and 38 oz. silver. The accounts show credits £448,734 for concentrates delivered, and a balance of profit of £129,398. Dividends amounting to £49,138, or 20%, have been paid on the preference shares, and the balance is carried forward. The developments during the year have been satisfactory, and the reserve has been increased by 214,086 tons. The total on December 31 was estimated at 1,185,870 tons averaging 14·8% lead, 9·3% zinc, and 2·4 oz. silver. This is all in the main lead lode, and nothing in the parallel zinc lode is included.

Great Fingall Consolidated.—This company was formed by Bewick, Moreing & Co. in 1899 to acquire a gold-mining property at Day Dawn, near Cue, West Australia. Milling started in 1900, and for eight years large profits were made. Subsequently the orebody began to decrease rapidly in assay-value. By the advice of Dr. Malcolm Maclaren, development was undertaken below the 14th level at a point 1000 ft. north of the main shaft. An auxiliary shaft was sunk and it is now down to the 18th level. Dividends on a much reduced scale were paid from 1909 to 1913. The report for the year 1914 shows that great trouble has been caused by the unsafe nature of the hanging wall. It became necessary to pack the old stopes with sand, and the plan was to rill the sand from the surface in the dry state, but the falls of hanging wall in the upper workings blocked the passage. It was then attempted to pass the sand down the main shaft. Here again a difficulty arose through the abnormal rains which damped the sand-heaps on the surface. Another method of transporting the sand had then to be devised. Under the conditions, it was necessary to suspend operations for two months, so that a smaller amount of ore was raised than during the previous year. This fact, together with the cost of clearing and packing, has resulted in a loss on the year's working. The ore raised was 44,006 tons, as compared with 64,255 tons the year before. The yield was 16,207 oz., and in addition 1295 oz. was recovered by re-treatment of accumulated sand and slag. The gold sold for £73,343, and the accounts show a loss for the year of £25,821. Little development work was done, and the reserve below the 13th level on December 31 stood at 63,360 tons averaging 35s. 3d. per ton. During the year, an alteration has been made in the method of treating the slime, continuous decantation being substituted for vacuum filtering.

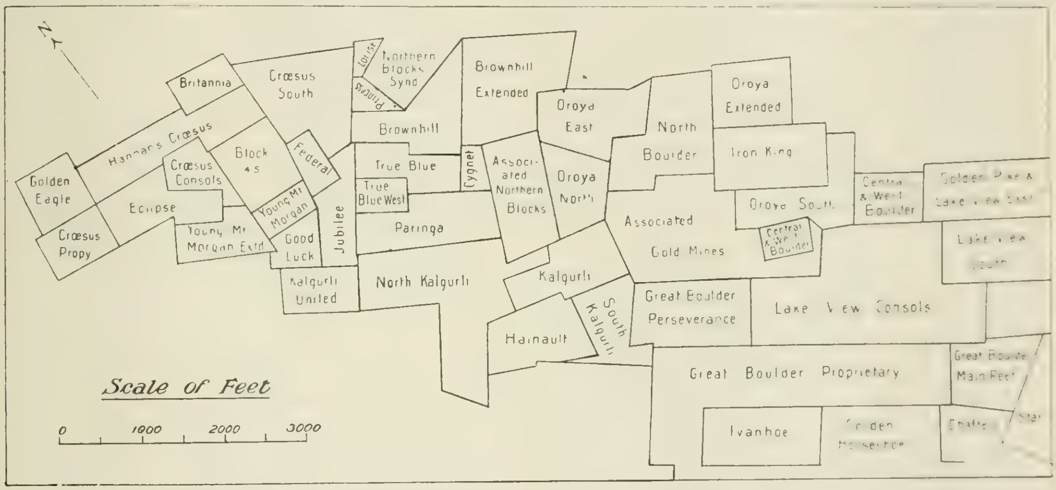
South Kalgurli Consolidated.—This company was formed in 1913 for the purpose of amalgamating the South Kalgurli and Hainault companies, operating mines on the same orebodies at Kalgoorlie, West Australia. The South Kalgurli had been worked since 1895 and small dividends were paid from 1905 to 1912. The Hainault commenced milling in 1901, and paid small dividends in 1905 to 1908, and 1911. The consolidated company paid 2½% dividend for 1913. The amalgamation was effected for the purpose of jointly exploring for further supplies of ore. The report for the year 1914 shows that 116,159 tons of ore was raised and treated for a yield of gold worth £137,682, or 23s. 8d. per ton. The net profit was £9634. The ore reserve is estimated at 165,146 tons averaging 6 dwt. gold per ton, and in addition 85,310 tons is returned as probable ore averaging 5·12 dwt. We have in previous issues referred to the favourable results obtained by diamond-drilling. The directors state that the position has improved sufficiently to warrant the resumption of the payment of dividends in the near future

Oroya Links.—This company was formed in 1896 as the Golden Links to acquire property at Kalgoorlie. It was reconstructed in 1902 and in 1907. In 1909 the 50-stamp mill of the Oroya-Brownhill and some of the low-grade mines belonging to that company were acquired by the issue of shares. The capital is £312,500, and small dividends were paid for 1910, 1912, 1913, and 1914. Bewick, Moreing & Co. are the managers. The report for the year 1914 shows that 86,838 tons of ore was raised from the Eclipse mine, 47,332 tons from the Oroya North, 9706 tons from the Brownhill, and 1254 tons from Block 45, a total of 145,130 tons. The yield was 36,950 oz. of gold, worth £156,668, or 21s. 7d. per ton. The accounts show a net profit of £14,416, out of which £14,375, or 5%, was distributed as dividend. Earlier in the year, a dividend of £14,375 was distributed out of the profits for 1913. Developments at the Eclipse have continued to expose ore, and on December 31 the reserve was estimated at 160,111 tons averaging 25s. per ton. At the Brownhill and Oroya North there are reserves of ore, but their amount cannot be reliably estimated.

Great Boulder Proprietary.—This company was formed in 1894 to acquire property at Kalgoorlie, West Australia. Dividends have been paid continuously since 1895, and during the last fifteen years the yield has been worth rather over half-a-million pounds per year. Richard Hamilton has been manager continuously. Three years ago the development at depth began to give disappointing results, and little ore has been found below the 2500-ft. level. The report for the year 1914 shows that 190,117 long tons of ore was raised and treated, and that the yield was worth £565,543. The net profit was £300,632, out of which £262,500 has been distributed as dividend, being at the rate of 150%. Development continues to disclose additional ore in the upper levels, and on December 31 the reserve was estimated at 560,647 long tons averaging 14·85 dwt. per ton, as compared with 615,114 tons averaging 14·5 dwt. the year before, so that a three-years supply is assured for the mill. Diamond drilling has been done in various directions, at depth and in the undeveloped ground outside the present workings, but no results of importance have been obtained.

Great Boulder Perseverance.—This company was formed in 1895 to acquire a gold-mining property at Kalgoorlie, West Australia. In those days Frank L. Gardner was chairman and Zebina Lane manager, and large profits were made from bonanza ore. The rich ore was exhausted in 1904, and since then the profits have been small or non-existent. Though the ore reserves are large, the grade has been low. Hooper, Speak & Co. have been consulting engineers since 1905. R. A. Varden is in charge of operations. The report for the year 1914 shows that 245,555 tons of ore was raised, and 61,150 oz. gold was recovered, worth £260,860, or 21s. 3d. per ton. The net profit was £27,996, which was carried forward. The reserve consists of 244,207 tons of broken ore, averaging 24s. per ton, and 350,800 tons in place of similar assay-value. In addition 334,780 tons is returned as 'probable,' averaging 21s. per ton. Since the end of the period covered by the report, the average assay-value of the ore broken has been lower than that of the reserve on December 31, being nearer that of the 'probable' ore, and the directors are aware that development may have to be stopped in the early future.

Lake View & Star.—This company was formed in 1910 to acquire the Lake View and Hannan's Star mines at Kalgoorlie, the former being taken over from the Lake View Consols company when the company was reorganized as an exploration and financing corporation. James Brothers are the consulting engineers, and Bewick, Moreing & Co. general managers. Dividends have been paid regularly since 1912. The report for the year ended February 28 last shows that 104,834 tons of ore was raised from the Lake View group and 113,290 tons from the Hannan's Star, being a total of 218,124 tons averaging 27s. 3d. per ton. The yield of gold was worth £252,796, or 23s. 5d. per ton. The working profit was £37,136, out of which £32,000 was distributed as dividend, being at the rate of 16%. At the Lake View mine, ore continues to be disclosed in the upper levels, and several shoots of ore have been found in the lowest level at 2100 ft. On February 28 the reserve was estimated at 101,580 tons averaging 27s. 7d. per ton. At Hannan's Star, no large amount of development was done, and the reserve was estimated at 324,721 tons averaging 26s. 6d. per ton, as compared with 368,604 tons averaging 26s. 7d. the year before.



MAP OF GOLD-MINING PROPERTIES AT KALGOORLIE.

Consolidated Goldfields of New Zealand.—This company was formed by the Exploration Co. in 1896 to acquire from David Ziman a number of properties in the Reefton district on the west side of the south island of New Zealand. The control passed from the Exploration Co. in 1903. The directorate now includes L. Ehrlich and E. T. McCarthy. The company operates the Wealth of Nations mine and holds controlling interests in the Progress and Blackwater companies. The report for 1914 shows that at the Wealth of Nations mine, 25,470 tons of ore was treated for a yield of gold worth £40,420. The working profit is returned at £15,954, but out of this £12,804 is allowed for development and depreciation, these items not being separated. The income also included £4566 received as dividend from the holding in Blackwater shares. At the Wealth of Nations, the ore reserve has been fully maintained, and stood on December 31 at 28,054 tons averaging 10·84 dwt. per ton. No dividend has been distributed.—**Blackwater Mines.**—During the year 1914, 50,426 tons of ore was treated for a yield of gold worth £100,132. The net profit was £19,834, out of which £12,499 was distributed as dividend, being at the rate of 5%. The ore reserve is estimated at 104,564 tons averaging 15·5 dwt. per ton, practically the same figures as the year before. Seeing that the ground is much faulted between the 5th and 6th levels, this result may be considered good. Developments on the 7th level are more satisfactory.—**Progress Mines.**—The report for 1914 shows that 33,150 tons of ore was treated for a yield of gold worth £47,766, and the dividends on Blackwater shares held brought a credit of £4314. The accounts showed a loss of £7708. The development has given disappointing results, owing to the folded and broken nature of the ground. It is difficult to make any exact estimate of the reserve, but it is approximately taken at 80,000 tons of unspecified content. A. Winter Evans is manager of this group of mines.

Wallaroo & Moonta.—This company has its headquarters at Adelaide, and operates copper mines in South Australia on the east side of Spencer Gulf. The 25th annual report shows that during the year 1914 the concentrate produced at the Wallaroo amounted to 56,365 tons averaging 9¼% copper, and at the Moonta 7467 tons averaging 15⅓% copper. At the Moonta in addition, 942 tons of precipitate was produced containing 738 tons of metal. The smelting works at Wallaroo treated 65,466 tons of concentrate, matte, and precipitate, for a yield of 7022 tons of copper, 2702 oz. gold, and 2936 oz. silver. For some years the copper has been purchased by Aron Hirsch und Sohn for German consumption. On the outbreak of war, steps were immediately taken to sell the output in London. By means of arrangements with the Union Bank of Australia for advances on copper shipped to London, and by the employees agreeing to a 20% reduction in wages, it was possible to keep the mines and smelter going without interruption. The accounts show credits for £423,524, and a profit of £39,997, out of which £24,000 has been distributed as dividend, being at the rate of 7½%. The Moonta mine has not for some time been worked at depth, and operations have been confined to the reclamation of old pillars. Pumping has been slackened, and the workings below the 1920-ft. level are full of water. The company's general position improved after the end of 1914, and the deduction from employees' wages was reduced from 20% to 10% in February.

Mount Lyell Mining & Railway. — The report of this company operating copper mines on the west coast of Tasmania for the half-year ended March 31 shows that little or no inconvenience was occasioned by the war, except for the low price of copper. The output was not curtailed, though development was suspended for a few months. The amount of pyritic smelting ore raised at the Mount Lyell was 106,572 tons averaging 0·44% copper, 1·75 oz. silver, and 0·8 dwt. gold, and of silicious ore raised at the North Lyell 66,678 tons averaging 6·32% copper, 1·16 oz. silver, and 0·14 dwt. gold. The production of blister copper was 3984 tons, containing 3939 tons of copper, 243,783 oz. silver, and 4995 oz. gold, the blister being delivered to the Port Kembla works of the Electrolytic Refining & Smelting Co. of Australia for treatment. On September 30 last the unsold copper amounted to 2317 tons. This has since been sold at an average price of £54. 3s. 4d. Of the copper produced during the half-year under review, 2645 tons has been sold at an average of £65. 2s. 10d., and 750 tons on a basis of average monthly prices. The amount remaining unsold on March 31 was 544 tons. The copper used to be sold through Aron Hirsch und Sohn, and since the war began other arrangements have been made. The accounts show a new profit of £98,220. The cost of the Lake Margaret hydro-electric installation was £164,353. The ore reserve on March 31 was calculated as follows: At the Mount Lyell, 1,894,728 tons averaging 0·53% copper, 1·96 oz. silver, and 0·55 dwt. gold; at the North Lyell, 1,039,042 tons averaging 6% copper, 1·33 oz. silver, and 0·1 dwt. gold. Large amounts of high-grade ore have been developed on the 1100 ft. and 1200 ft. levels of the North Lyell, and the reserve has been increased by 79,210 tons. A flotation plant has been ordered.

Alaska Treadwell.—This company was formed in 1890 to acquire the Paris gold mine on Douglas island, Alaska, which was first opened in 1882. Adjoining property is worked by the Alaska Mexican and Alaska United companies, which were formed under the same control in 1892 and 1895 respectively. The office is in San Francisco, and F. W. Bradley is president. Two years ago, a new plan for working the deeper portions of the lode was inaugurated, the ground below the 1750-ft. level being left intact until 2100 ft. was reached, and a new mine opened on the latter level. This lower part of the lode in the territory belonging to the three companies named is being worked from the vertical shaft of the 700 Ft. Claim of the Alaska United, which is between the Treadwell and the Mexican. The report for the year 1914 shows that 910,285 tons of ore was raised and sent to the 540 stamps. The yield of gold by amalgamation was $1,264,945, and by the cyanidation of sulphide concentrate $1,102,616, being a total of $2,367,561, or $2·60 per ton milled. The operating cost was $1,083,972, or $1·19 per ton, leaving a profit of $1,351,402 or $1·48 per ton. The sum of $250,953 was written off for depreciation, and $1,100,000 was paid as dividend, being at the rate of 22%. The total yield to date has been worth $36,332,186, and $14,885,000 has been distributed in dividends. The reserve on December 31 was estimated at 7,159,253 tons averaging $2·48 per ton. The average assay-value of samples taken on the 2100-ft. level in the Treadwell ground is $1·82 per ton.

Alaska Mexican. — Details of the history of this company are given in the preceding paragraph. The report for 1914 shows that 233,457 tons of ore was raised and sent to the 120 stamps. The yield by amalgamation was worth $238,756, and by the cyanidation of sulphide concentrate $270,267, making a total of $509,023, equal to $2·13 per ton milled. The operating cost was $343,298, leaving a profit of $170,020, or $0·73 per ton. Out of the profit, $25,451 was written off for depreciation, and $144,000 was distributed as dividend, being at the rate of 16%. The ore reserve was estimated on December 31 at 688,738 tons averaging $2·68 per ton, as compared with 816,882 tons averaging $2·53 at the end of 1913, and 1,040,631 tons averaging $2·75 at the end of 1912.

Alaska United. — This company owns the 700 Ft. Claim between the Alaska Treadwell and the Alaska Mexican, and also the Ready Bullion mine, a detached property farther to the east. The report for 1914 shows that at the Ready Bullion, 233,100 tons of ore was raised, and that the yield by amalgamation was worth $282,036, and by cyanidation of sulphide concentrate $252,371, being a total yield of $534,407, or $2·29 per ton. The net profit was $191,827, or $0·82 per ton. At the 700 Ft. Claim, 225,214 tons was raised. The yield by amalgamation was worth $230,509, and by cyanidation of concentrate $200,874, a total of $431,383 or $1·91 per ton. The net profit was $66,112 or $0·29 per ton. After $81,153 had been allowed for depreciation, the profits at the two mines afforded a dividend of $162,180, or 18%. The ore reserve at the Ready Bullion was estimated on December 31 at 2,144,062 tons averaging $2·68 per ton. Owing to the dip of the orebody becoming steeper, the incline shaft is a long way from the ore at the lower levels, so it is proposed to sink a new shaft in a more convenient position. At the 700 Ft. Claim, the development on the 2100-ft. level has not so far given particularly promising results, as the samples assayed vary in gold content from 50 cents to $3·25. Further development is necessary before the economic value of the orebody at depth can be correctly estimated.

Canadian Mining Corporation. — This company was formed in London in March 1914 to acquire the majority of the shares in the Mining Corporation of Canada, a company registered under Canadian laws at the same time to consolidate the properties of a number of companies at Cobalt, Ontario. These mines are the Townsite, Lake, City, Townsite Extension, and Little Nipissing. Sir A. C. F. Fitz-George is chairman of the English company, and Sir Henry M. Pellatt of the Canadian company. D'Arcy Weatherbe is consulting engineer, and C. E. Watson manager. The report of the Canadian company for the nine months ended December 31 shows that at the Townsite-City group, 408 tons of high-grade ore yielded 911,205 oz. of silver, and 1945 tons of concentrate and slime 1,401,268 oz. At the Lake mine, 256 tons of high-grade ore yielded 356,342 oz., and 559 tons of concentrate and slime 516,308 oz. The total yield was 3,185,124 oz., which sold for $1,629,892. Dividends from holdings in the Cobalt Reduction Co. brought an income of $133,678, and there were other items of revenue amounting to $11,295, making the total income $1,774,865, or $16·53 per ton of ore treated. The operating cost was $984,579, or $9·16 per ton, leaving a working profit of $790,286 or $7·37 per ton. The expenditure on capital account amounted to $127,938, spent on draining Cobalt lake and on shaft-sinking, and of this $38,180 was written off the revenue account. Out of the profits, $154,896 was disbursed as royalties, taxes, commissions, and administration expenses, and $259,375 was distributed as dividend, the remainder being carried forward. Since the end of 1914 another dividend of similar amount has been declared. The English company's financial year ended on March 31, and the income from dividends paid by the Canadian company was £98,153, out of which £76,456 was distributed among shareholders, being at the rate of 5%. The ore reserve at the Townsite mine is estimated at 209 tons averaging 2250 oz. per ton, and 76,113 tons of concentrating ore averaging 20 oz. per ton; at the City mine 454 tons averaging 1900 oz. per ton, and 17,249 tons averaging 20 oz. per ton. At the Lake property the amount in reserve that can safely be attacked by underground operations is estimated at 24,000 tons averaging 33 oz. per ton. When the water is pumped out of the lake, other ore will be available. Development has yielded satisfactory results, and several new veins were discovered. In particular, the work done at the north end of the property in the City area was highly encouraging, large amounts of rich ore being disclosed.

Esperanza.—This company was formed in 1903 to acquire a majority of the shares of the Esperanza Mining Co., a New Jersey corporation operating the Esperanza mine at El Oro, Mexico, between the El Oro and Mexico mines. Handsome profits were made for eight years, but subsequently the developments gave poor results, and at the present time operations are confined chiefly to re-opening low-grade stopes in the upper levels and reclaiming waste-filling. The report for the year 1914 shows that milling was conducted under normal conditions from January 1 to April 24, on which date the political troubles made it necessary to suspend operations. Milling was re-started on August 31, and continued until the end of the year, but on a restricted basis, owing chiefly to the difficulty of obtaining cyanide. After the end of the financial year covered by the report, milling was continued until the end of February, when all transport facilities came to an end, and it became impossible either to obtain supplies or to ship bullion. During the year under review, 120,975 tons of ore and old filling was sent to the mill, together with 45,237 tons of old tailing from the dump. These figures show an increase of 35,132 tons of ore and old filling as compared with the previous year, and a decrease of 76,201 tons of old tailing from the dump. The gross value of the gold and silver bullion and the concentrate was $1,039,698, and the working profit was $402,426. The New Jersey company declared dividends amounting to $157,500, and the shareholders in the English company received £22,750, the dividend being at the rate of 5%. The ore reserve is estimated at 148,254 tons, which should yield a mining profit of £91,487. In addition, the extraction of old filling should continue to yield profits. It is estimated that the treatment of the tailing dump will afford a profit of £41,025. The developments on the San Carlos vein have given disappointing results. Those on the upper levels of the San Rafael vein have disclosed large amounts of low-grade ore, and of old filling that will, under present conditions, pay for treatment. On the Discubridora lode, a narrow shoot of high-grade ore has been found between the 1st and 3rd levels, and the profitable parts so far disclosed assay 1½ oz. gold and 30 oz. silver per ton over a width of 5 ft. The company also owns the Sirio and Suceso claims, farther to the south, on the other side of the El Oro company's property. Work has recently been re-started on the Sirio, and the shaft has been re-opened to a depth of 500 ft.

Buena Tierra.—This company was formed by the Exploration Co. at the beginning of 1912 to acquire a silver-lead property, previously worked by local owners, in the Santa Eulalia district, Chihuahua, Mexico. The ore is lead carbonate, high in iron, with some silver, and is shipped to the American Smelting & Refining Co's. smelter at Chihuahua. Political disturbance has interfered with operations. The report for the year 1914 shows that shipments were irregular, being entirely stopped during the months of January, May, and June, and during the latter half of the year only sufficient ore was mined to cover expenses. The total amount shipped was 16,307 tons averaging 11·7% lead and 8·96 oz. silver. During the previous year, 25,972 tons was shipped averaging 14% lead and 8·2 oz. silver. The sales of ore yielded an income of £23,147, and a net profit of £5908 was made. The sum of £20,733 was brought in from the previous year, so that the balance of profit was £26,642. Out of this, a dividend at the rate of 5% has been paid, absorbing £16,500. Sufficient development has been done to maintain the reserve at 300,000 tons.

St. John del Rey.—This company was formed in 1830 for the purpose of working the Morro Velho gold mine in the state of Minas Geraes, Brazil. In 1888 a serious crisis was caused by a collapse of the workings. The saving of the mine was undertaken by George Chalmers, and he has been in charge of operations ever since. An excellent account of the mine and its present condition was given in T. A. Rickard's paper dealing with the persistence of ore in depth, read last year before the Institution of Mining and Metallurgy. The report for the year ended February 28 shows that the sinking of the G shaft has been completed to the 20th horizon at a vertical depth of 5826 ft. below the surface outcrop, and that drifts have been started at the 19th horizon 5526 ft. below surface and at the 20th horizon to meet the lode. During the year, the labour conditions have been much more satisfactory, so that both the extraction of ore and the development show a substantial improvement as compared with the year before. The amount of ore raised was 199,234 tons, and after the rejection of 4% waste, 191,500 tons was sent to the treatment plant. The yield of gold was worth £455,927. During the previous year, 174,000 tons was treated for a yield of £414,410. The working profit was £144,092, out of which £1153 was paid as debenture interest, £10,000 was paid as dividend on the 10% preference shares, £10,000 was placed to reserve, £50,000 was placed to capital account, and £54,626 was distributed as dividend on the ordinary shares, being at the rate of 10%. The yield per ton was 47s. 7d., which closely follows the figures of recent years. Mr. Chalmers has continued his study of underground temperatures and ventilation, with a view of ascertaining approximately the conditions below the 20th horizon. In order to obtain the additional power that will be required for ventilation and for hoisting at greater depths, an extension of the hydro-electric plant in Rio de Reixe is contemplated, which will afford an additional 1260 hp

Poderosa.—This company was formed in 1908 to acquire from local owners a group of copper mines at Collahuasi in the Andes, in the republic of Chile, not far from the main line of the Antofagasta & Bolivia railway. Large amounts of high-grade ore had been mined and shipped. The directors of the English company continued to ship, and distributed profits instead of spending money on development at depth. The efforts of several managers in succession have failed to retrieve the position. The report for the year 1914 shows that 5206 tons of ore averaging 18·8% copper was shipped, as compared with 7793 tons of the same tenor during 1913, and 11,318 tons averaging 22% copper during 1912. The accounts show a loss of £28,574 for the year. J. H. Ivey, the manager, states that the reserves of shipping ore in the Poderosa and San Carlos on December 31 were about 2740 tons, and that the prospects of finding any more are small. There is, however, a large amount of ore of lower grade that can be concentrated, and low-grade ore on the dumps remains to be treated. The dressing plant has since been completed.

Prestea Block A.—This company was formed by Edmund Davis in 1903 to acquire a gold-mining property in West Africa from the Prestea and Appantoo companies. Additional property was subsequently acquired from the Appantoo company, and, later, the whole of the property of the Prestea company was absorbed. Milling commenced in 1906, but was suspended from 1909 to 1911 pending further development. Additional working capital has been provided from time to time by Wernher, Beit & Co., the Central Mining & Investment Corporation, and the Fanti Consolidated, either by subscription for shares or on loan. Hugh F. Marriott is consulting engineer and William Crosley is manager. The report for the year 1914 shows that 270,732 tons of ore averaging 39s. 6d. per ton was raised and sent to the mill. The yield of gold by amalgamation was worth £301,498, that won from concentrate £94,120, and by cyaniding sand £31,262, making a total yield of £426,881, equal to 31s. 6d. per ton. The slime is not treated at present, and 59,629 tons averaging 10s. 6d. per ton was stored. The mining and milling plant is now working at full capacity, that is to say on the basis of 80 stamps employed. The installation as provided in 1911 contained 110 stamps. Experiments are still being conducted on the plan adopted by the advice of W. R. Feldtmann with a view to increase the efficiency of the cyanide extraction. Presumably the new process is on the lines of treatment by alkaline sulphides, as described by Mr. Feldtmann in his paper read before the Institution of Mining and Metallurgy in April. No material progress with the new process has been possible so far. The ore from certain parts of the mine is now reported to be more difficult to treat, and there appears to be a smaller amount of amalgamable gold in the ore. Development during the year disclosed 254,674 tons of ore averaging 42s. 9d. per ton, and on December 31 the reserve stood at 554,137 tons averaging 40s. 4d. per ton, together with 92,473 tons in the poor zone averaging 27s. 7d. per ton. The working cost for the year is returned at £345,241, or 25s. 6d. per ton. Out of the profit, £43,567 has been written off for depreciation of plant, £6443 has been paid as interest on loans, £3691 has been spent on research work, and the balance is carried forward.

Lahat Mines.—This company was formed in 1906 to acquire a tin-gravel property at Lahat, in Perak, Federated Malay States. The promoter, E. G. Edgar, was also the promoter of the Tronoh Mines, and the Lahat and Tronoh have the same office and secretary. The report for the year 1914 shows that 299,271 cubic yards of gravel was treated, for a yield of 360 tons of tin concentrate, as compared with 284,676 cu. yd. and 381 tons the year before. The yield in 1909, the first year of operation, was 595 tons. The accounts show credits of £32,770 for tin concentrate produced, and a debit balance of £2315. A year ago the profits permitted the distribution of £10,500 as dividend, at the rate of 8¾%. The fall in the price of tin, and the difficulty of selling concentrate during the months after the outbreak of war, account for the adverse results. New pumps and power plant have been erected, and a saving in cost has already been effected.

Guiana Gold.—This company was formed in 1905 to acquire the St. Mary's alluvial concessions in British Guiana. Four dredges are at work over 20 miles of river. Dividends have been paid regularly since 1908, the total being 82½% on a capital of £50,000. The report for the year ended March 31 shows that the yield was equal to 8342 oz. of fine gold, as compared with 7407 oz. the year before. The dredges have been overhauled and re-fitted during the year, and the cost charged to revenue. The net profit was £4150, out of which £3750 was distributed as dividend, being at the rate of 7½ per cent.

The Mining Magazine

Scientia non habet inimicum nisi ignorantem.

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STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,998	363,826	8,794,824	37,358,040
July, 1914	703,136	29,349	732,485	3,111,398
August	684,607	27,311	711,918	3,024,037
September	677,063	25,107	702,170	2,982,630
October	703,985	29,761	733,746	3,116,754
November	685,450	30,386	715,836	3,040,677
December	669,075	26,062	695,137	2,952,755
Year 1914	8,033,567	344,570	8,378,139	35,588,075
January 1915	689,817	25,167	714,984	3,037,058
February	653,213	23,008	676,221	2,872,406
March	727,167	26,768	753,935	3 202,514
April	717,225	26,855	744,080	3,160,651
May	737,752	25,796	763,548	3,243,347
June	727,924	27,356	755,280	3,208,224
July	742,510	27,845	770,355	3,272,258

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
January 31, 1914	154,202	9,471	11,979	175,652
February 28	157,673	9,508	12,266	179,447
March 31	162,815	9,619	13,390	185,824
April 30	165,005	9,625	14,150	188,780
May 31	165,433	9,619	14,284	189,336
June 30	166,248	9,442	13,256	188,946
July 31	167,006	9,257	13,656	189,919
August 31	168,851	9,485	—	178,316
September 30	169,619	9,389	—	179,008
October 31	170,438	9,212	—	179,650
November 30	166,039	8,990	—	175,029
December 31	164,650	8,704	—	173,354
January 31, 1915	172,331	8,675	—	181,006
February 28	180,422	8,494	—	188,916
March 31	185,239	8,216	—	193,455
April 30	186,941	8,418	—	195,359
May 31	183,961	8,857	—	192,818
June 30	184,155	9,019	—	193,174
July 31	190,026	9,371	—	199,397

Cost and Profit on the Rand

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Year 1912	25,486,361	29 2	19 3	9 11	12,678,095
Year 1913	25,628,432	27 9	17 11	9 6	12,189,105
January 1914	1,902,733	27 4	18 2	9 3	876,577
February	1,861,442	26 10	17 11	8 10	823,654
March	2,094,098	26 4	17 3	9 1	945,000
April	2,075,561	26 6	17 3	9 3	955.600
May	2,196,287	26 3	17 0	9 3	1,011,968
June	2,178,161	25 5	17 1	9 5	1,025,629
July	2,281,717	25 10	16 9	9 1	1,032,562
August	2,261,800	25 5	16 8	8 9	988,567
September	2,188,939	25 11	16 9	9 1	989,859
October	2,301,795	25 8	16 8	8 9	1,004,264
November	2,192,365	26 3	17 0	9 0	982,346
December	2,167,056	25 11	17 3	8 6	917,662
Year 1914	25,701,954	26 6	17 1	9 0	11,553,697
January 1915	2,237,748	25 10	17 5	8 3	920,194
February	2,077,792	26 4	17 11	8 4	867,782
March	2,366,392	25 9	17 4	8 4	985,511
April	2,289,002	26 4	17 5	8 9	996,846
May	2,416,966	25 8	17 0	8 6	1,031,220

The above are the official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 70% of the working profit.

Production of Gold in West Africa.

Year 1912	Year 1913	Year 1914	June 1915	Year 1915
£1,497,179	£1,634,700	£1,727,044	£135,289	£868,843

Production of Gold in Rhodesia.

Year 1912	Year 1913	Year 1914	June 1915	Year 1915
£2,707,368	£2,903,267	£3,530,207	£322,473	£1,836,520

Gold Output of India.

Year 1912	Year 1913	Year 1914	July 1915	Year 1915
£2,265,094	£2,299,315	£2,340,259	£196,295	£1,380,950

Production of Gold in Western Australia.

	Export oz.	Mint oz.	Total oz.	Total value £
Total, 1913	86,255	1,227,888	1,314,143	5,582,140
July, 1914	8,294	88,305	96,599	410,324
August	101	102,346	102,447	435,164
September	1,535	103,577	105,112	446,485
October	2,028	99,366	101,394	430,692
November	1,217	109,282	110,499	469,387
December	1,214	101,534	102,748	476,253
Total, 1914	51,454	1,181,520	1,232,974	5,237,308
January 1915	561	98,196	98,757	419,495
February	607	103,661	104,258	442,900
March	1,829	91,872	93,764	398,282
April	1,017	101,592	102 609	435,853
May	2,311	101,359	103,670	440,360
June	1,273	100,036	101,309	430,333
July	555	98,859	99,414	422,271

Other Australian Gold Production.

	1913	1914	June 1915	1915
	£	£	£	£
Victoria	1,847,400	1,740,300	134,200	681,400
Queensland	1,118,610	1,011,310	90,500	546,460

Exports of Copper from United States
(Reported by United States Customs).

Month	Long Tons	Month	Long Tons
July, 1914	34,145	January, 1915	28,197
August	19,676	February	12,066
September	23,866	March	29,725
October	28,995	April	20,481
November	20,170	May	25,785
December	16,830	June	15,751

Nigerian Tin Production.

In tons of concentrate of unspecified content.

Year 1912 tons	Year 1913 tons	Year 1914 tons	June 1915 tons	Year 1915 tons
2,532	5,032	4,832	373	2,367

Production of Tin in Federated Malay States.

Estimated at 70% of concentrate shipped to smelters.

1911 tons	1912 tons	1913 tons	1914 tons	June 1915 tons	1915 tons
43,967	48,250	50,128	49,042	4,048	23,318

Sale of Tin Concentrate at Redruth Ticketings.

	Tons	Value	Average
Year 1911	6151½	£702,599	£114 4 5
Year 1912	6492	£831,908	£128 5 6
Year 1913	6186	£744,268	£120 2 6
Year 1914	4987	£432,437	£86 14 3
January to June 1915	2826	£261,958	£92 13 10
July 5	202	£18,721	£92 13 5
July 19	204½	£18,102	£88 10 5
August 3	177	£15,069	£85 2 9

Imports of Tin Concentrate into United Kingdom.

	July		Year 1915	
	Tons	Value	Tons	Value
		£		£
Bolivia	3,237	290,260	23,753	2,011,646
Other Countries	1,205	104,679	5,847	544,732
Total	4,442	394,939	29,600	2,556,378

REVIEW OF MINING

INTRODUCTORY.—The mining situation has not greatly changed in the last month, as is shown by our review which follows. Metal prices have sagged but are still high. An active discussion has been raging as to a reputed 'zinc trust' in America, and a German metal monopoly. In the course of this considerable nonsense has been talked. The truth is that the 'monopoly,' so far as there has been one, has been by an international group in which Germans, British, Americans, and even Australians worked together. It has been directed toward control of the markets rather than of production. It was based upon skill in trading rather than skill in technology. There have always been large independents, and the charge that present high metal prices are in some way due to market manipulations by enemy companies is not sustained by the facts. Lake copper has always been in especial demand for war purposes, and is now at the top of the market, but not a single Lake company is controlled by any member of the international group. To anyone who knows American conditions also, the suggestion that the Anaconda company, the largest copper producer in the United States, the Phelps Dodge companies, and others that might be mentioned, are not independent in their marketing, is humorous. In spelter the 'Horsehead' and 'Bertha' brands have long stood at the head for cartridge brass. Both are made by the New Jersey Zinc Company which is as American as the Woolworth building and two of whose most important directors answer to the good old Welsh name of Jones, their ancestors in fact having come from Swansea. The company itself, the largest American zinc-producing company, is so independent as to be a constant thorn in the flesh of its competitors. There is no zinc trust in the United States and the attempt of a Missouri Prosecuting Attorney to make political capital by bringing indictments against a large number of companies means nothing. In London diverse and sundry editors have been misled by the German form of certain American names and have shown much unnecessary alarm. Matthiessen & Hegeler, for example, were pioneers in zinc smelting in the United States in the middle of the last century. They did excellent work and long since passed to their reward. The works with the terrifying name now belong to Mary Carus, daughter of one of the pioneers and wife of an innocent philosopher.

TRANSVAAL.—The output of gold on the Rand during July was 742,510 oz., and in the outside districts 27,845 oz., making a total of 770,355 oz., worth £3,272,258, as compared with 755,280 oz. worth £3,208,224 in June. The number of natives employed on the gold mines on July 31 was 190,026, as compared with 184,155 at the end of June, and 167,006 a year ago.

Developments at the Brakpan during the quarter ended June 30 gave excellent results, the average assays along the whole of the driving on the reef, 4685 ft., being 15·68 dwt. over 32·7 inches. Of the driving, 2690 ft. was in profitable ore averaging 24·14 dwt. over 34·2 inches. During the corresponding quarter of last year 4415 ft. was driven on the reef, 1985 ft. being in profitable ground averaging 13·4 dwt. over 40·9 inches. The current figures evidently indicate the discovery of rich ore in depth.

The metallurgical plant at the Modder Deep is to be increased by the addition of 10 stamps and accessories, bringing up the number of stamps to 85. The capacity of the extended plant will be 40,000 tons per month. The present plant was designed for 30,000 tons per month, but is actually treating 35,000 tons. The cost of the new plant is estimated at £23,000, and it will be met out of profits.

The directors of the City & Suburban have issued a statement as to the probable life of the mine. The developed reserve is calculated at 758,700 tons averaging 8½ dwt. In addition, 190,000 tons of ore averaging 5·8 dwt. can be reclaimed from old workings. The portion of the claim-area undeveloped is estimated to contain 740,900 tons in the Main Reef Leader, the average content being taken at 8·9 dwt. This total reserve is sufficient to keep the mill supplied for 4½ years from the present date. The company has an option on 2·7 City Deep claims, which, if the option is exercised, will add to the life of the mine, and there are blocks of low-grade ore which may possibly be worth working, so that the directors expect that the operations may extend to 7 years.

The New Rietfontein, belonging to the Barnato group, is to be closed down, as the operations have lately involved losses, and there is no prospect of new ore reserves being developed. This mine is eight miles north of Johannesburg and is off the Main Reef Series, on the Du Preez reef, the correlation of which still affords subject for discussion. Dividends of 25% were paid in 1893, and from 1905 to 1912 the total distribution was 122½%. Since the latter year, conditions have been discouraging.

RHODESIA.—The output of gold during June was worth £322,473, as compared with £318,898 in June and £337,241, the highest recorded, in October last. Lonely Reef and Falcon both exhibited slight increases.

Four months ago the Wanderer distributed £60,000 among its shareholders as a return of capital following the reduction of the par value of the shares from 5s. to 3s. Since then it has been possible to distribute a further £15,000 as dividend, being at the rate of 16⅔% on the reduced capital, £90,000. The engineers report that there is little chance of mining being continued after November.

The figures for gold extraction presented in the annual report of the Shamva are of interest to metallurgists. For the first five months after the start in January 1914 the actual recovery was about 73%, and it was estimated that nearly 20% of the gold contained in the ore was being absorbed in the plant. For the six months following, to the end of 1914, the actual extraction corresponded to a 99% recovery, though the theoretical recovery calculated from the assays of the feed and tailing only called for 92%. Investigation showed that large amounts of gold were absorbed in the tube-mill linings, and on relining this gold was recovered, thus explaining the high figure 99%. The working cost at the mine and mill averaged 8s. 1d. per ton, a figure slightly less than was originally estimated. The exploration of the orebody at depth has been re-commenced since the mill got into regular working order. It will be remembered that the orebody is large and wide down to the 3rd level, and shows a contracted area on the 4th. By means of cross-cuts and drifts much ground has recently been tested on the 4th level, with disappointing results as compared with the upper levels. A 5th level has been opened, and a limited amount of ore has been found. A telegram from the manager read at the annual meeting announced the finding of 16 ft. of 6 dwt. ore in No. 5 cross-cut from winze 77. The directors, and Mr. H. A. Piper, the consulting engineer, intend to inaugurate an extended campaign by cross-cuts, drill-holes, and geological examination for the purpose of exploring at depth. In the meantime, the ore reserve, 2,000,000 tons averaging 5¼ dwt., will keep the mill going for 3 years from the present date.

The production of copper by the Union Minière du Haut Katanga for the year 1914 was 10,722 tons produced from 92,381 tons of oxidized ore. The rate of output is increasing, rising from 997 tons during January to 1405 tons in June. Three furnaces are now working and the output for the year is expected to be at least 14,000 tons. Two more furnaces are being built and they will be ready in 1916. The normal output will then be about 25,000 tons per year. Mr. A. E. Wheeler is studying the problem of the low-grade ore and a report should be in hand within a year. After that still further increase in output may be expected.

WEST AFRICA.—The yield of gold continues to decrease, June being the fourth month in succession to show a fall. The output was worth £135,289 as compared with £142,123, £149,978, and £153,770 in the preceding months. At Prestea Block A the yield was worth £29,673 obtained from

20,090 tons, as compared with £34,196 from 22,300 tons in May.

The Ropp Tin company owns tin land on the watersheds of the Dome and South rivers, south of Bukuru. W. E. Thorne conducted extensive drilling here last year, and the prospecting work was continued under the direction of Messrs. J. Fordyce Balfour and J. Daniel, the superintending engineer and manager respectively. The tested ground is estimated to measure nearly 6,000,000 cu. yd. and to contain about 11,500 tons of 70% concentrate. Orders have been given for two dredges, having close-connected buckets of $2\frac{3}{4}$ cu. ft. capacity, to be driven by oil engines. An average of 30 tons per month is now being obtained by calabashing.

AUSTRALASIA.—The Australian Federal Government has prohibited the export of gold whether in the form of bars or contained in blister copper. A surface find of gold has been made by prospectors at a point 10 miles from Coolgardie, on the north side of the railway joining Coolgardie and Kalgoorlie.

The Broken Hill Associated Smelters reports that the extension of the lead plant will consist of one smelting furnace and three Dwight-Lloyd sintering furnaces. Ten zinc furnaces are at work.

The boards of the Broken Hill mining companies have reason to thank the men for their considerate attitude with regard to the wages problem. The labour agreement terminated at the end of June, and the new proposals on the part of the men were expected to raise unpleasant controversy. The men, however, have decided to continue on the old terms until six months after the end of the war.

The difficulty of making a British zinc-smelting industry independent of the Continental factor is exemplified by the case of the Central Zinc company, the subsidiary of the Sulphide Corporation, treating Broken Hill concentrate at Seaton Carew, near Hartlepool. The outbreak of war made it necessary to dismiss many unnaturalized German workmen, a substitute had to be found for the Belgian clay used in the manufacture of retorts, and the contract for the sale of silver-lead residue to German buyers had to be rescinded. As regards labour, the company was able to replace the enemy aliens by Belgian refugees. A plan is now being considered for the extension of the works on a much larger scale, and for the establishment of zinc-sheet mills. If the plan matures, the company is to be absorbed by the Sulphide Corporation, which will be better able to finance the new enterprise.

At the Ivanhoe, the bore-hole sunk from the 3320-ft. level indicates a chance of the orebody leaving the porphyry, where it is of low grade, and Mr. R. B. Nicolson, the manager, is encouraged to continue shaft-sinking to 3470 ft. His proposal is to start another bore-hole at the deeper level.

The Chaffers is one of the Kalgoorlie mines that have never paid dividends. The mine adjoins the Great Boulder Proprietary and the Golden Horseshoe on the south. The total output since 1893 has been £218,960 from 129,486 tons. Recently, additions were made to the plant increasing the capacity to 7000 tons per month. The directors have had a plan for reconstruction in hand for a long time, but have been baulked first by delay on the part of the Treasury in granting permission, and afterward by the refusal of the underwriters to extend the period covered by their offer. The matter is now in the hands of shareholders, who will have to decide whether operations shall continue or not. If the reconstruction is effected, John Taylor & Sons are prepared to undertake the management. It is a long time since this firm was connected with Kalgoorlie. In the early days they were consulting engineers to the Great Boulder Proprietary.

CANADA.—The most interesting, and possibly the most significant, announcement of the last month has been the report of rich ore on the 6th level at the Dome mine at Porcupine. It will be recalled that the average value of the ore fell rapidly as the mine increased in depth from about \$10 at the surface to a general average of \$4·68 as milled last year. Mr. W. W. Mein, then in charge, accordingly developed and equipped the property on the basis of its being a large low-grade mine, and with excellent results, as we have already noted. Exploration by diamond drill indicated the presence of richer ore in depth, but a wise conservatism based upon experience with the erratic distribution of gold in the ancient schists made both management and public cautious in estimating the reserve. Now it is announced that underground work confirms the showing of the drill, and that cross-cut 607 passed through 65 ft. of ore averaging $21·43 in value. Cross-cut 608 is being driven to confirm a drill finding of 153 ft. of ore worth $14·48. For 35 ft. of this distance the average already shown by the cross-cut is $19. Reducing the general average to $15, the manager, Mr. C. D. Kaeding, is quoted as estimating an addition to the ore reserve of $5,625,000. With the low working costs at the Dome, this should be mined with large profit. The Hollinger, not far away, is milling ore now averaging $9·23 per ton at a rate of 24,000 tons per month. The Hollinger grade has held fairly steady from level to level. While the Dome fell it has now recovered, and a really large body of high-grade ore has been found at depth. This confirms the judgment of those engineers and geologists who hold that in such ancient veins favourable as well as unfavourable irregularities in depth may be anticipated if development be but persistent and intelligent. From this point of view Dome developments are of great general significance.

UNITED STATES.—The Secretary of the Interior, Mr. Franklin K. Lane, has instituted a mid-year review of the mineral industry and has given to the press a series of brief summaries prepared by the experts of the United States Geological Survey. While definite figures comparable to those furnished in the annual volumes of the Survey are available in but few instances, it is interesting to note that despite the fact that copper, zinc, quicksilver, antimony, and other metals affected directly by the war demand are at high prices and production is being forced, the general industry is depressed. This puts matters in their proper relations, since the United States is not gaining by the war but is merely losing less than the combatant countries. It has much more to gain by peace than by the exhaustion of its neighbours. For example, the great fundamental industry of coal mining in the first six months of 1915 showed a smaller output than for the corresponding period in 1914, and one little if any greater than for the second half of that year. The mines are in fact running at 10 to 15% less capacity than the average for last year. This means many cold boilers throughout the nation, for an unusual part of even the present output is going to foreign markets. There has been apparently a slight increase in petroleum production, but it has gone into storage, and prices have been as much as 50% lower than last year. In iron conditions are better. Late shipments of iron ore for May were 30% above those of a year ago, and the pig iron output has increased month by month, though in May it was still below March 1914. The mills anticipate large orders and are building extensions, but the iron and steel trades are still sub-normal. Gold mining is active though there is no boom in shares of new mines. Silver mining continues dull except as an incident to production of other metals or where rich ore makes low costs as at Tonopah. Copper mining is prosperous—by comparison. That is, the big producers are now about at their normal, and high prices have brought in all the little fellows. Antimony, quicksilver, tungsten, molybdenum, and other minor metals are in great demand, and their producers are enjoying unexampled prosperity though the total business is small. The zinc furnaces are working to capacity and high-grade ore is at unheard of prices, but the more numerous owners of low-grade are restricted as to output and saddened thereby. Lead prices showed a flurry recently, but the effect in the year's output is not likely to be large.

ALASKA.—Considerable anxiety was caused by publication in the *Mining and Scientific Press* for July 3 of accounts of accidents at Treadwell in June. The main shaft of the big central hoist, it seems, broke on June 19, a few days after there had been an extensive cave in the upper workings of the Treadwell mine. Later information indicated that the resulting interruption of output was much shorter than the public was led to anticipate by this first announcement. In fact the 300-stamp mill was got going by July 1, and full operations were resumed July 12. As it was necessary to send to Seattle, Washington, to obtain shafting large enough for the big winding engine, this quick work reflects great credit on Mr. P. R. Bradley, the manager, and his staff. The full effect of the cave, which in the north orebody extended to the 900-ft. level and in the south to the 1400-ft., cannot now be estimated. It is reported that 100,000 tons of ore was involved. Since in the Treadwell mine alone down to 1450 ft. there was a reserve of 2,700,000 tons, it will be seen that the proportion involved was small. Much, if not all, of the caved ore can be won, so that this feature may be dismissed as not affecting the value of the property. It will be remembered that in opening the lower levels of the Treadwell unusual precautions had been taken against the loss of the mine in case of caves in the old stopes. Such breaks are not altogether to be avoided in large scale mining. If foreseen they may bring quite as much benefit as loss, since gravity costs nothing while dynamite must be paid for. We understand that the old No. 2 shaft at Treadwell has been re-commissioned and will be sunk to the same depth as the Central, so as to afford hereafter two outlets immediately available for hoisting.

MEXICO.—The political situation still dominates the mining industry. Spurred to activity by the threat of intervention, the Carranza administration drove the Zapata forces out of the City of Mexico and re-established communications with the coast. The mines at Pachuca were enabled to bring in supplies and the acute famine in the City was ameliorated if not relieved. The American Red Cross sent in supplies and began systematic work. This improved condition lasted only a short time. The Villa forces moved against Pachuca and then Carranza's troops went out to attack them. The Zapatistas were said to have re-occupied the capital. At any rate communication with the City was broken and Carranza's hope of recognition of the United States disappeared. We learn that communications have since been re-established as far as the City, but El Oro continues isolated. Early in August President Wilson called a conference of the representatives of the leading South and Central American countries at Washington. The result was a declaration backed by all, and addressed to the Mexican chiefs to the effect that order must be restored and proposing a conference among them with that in view. Villa has signified his willingness to attend, but the others have not yet done so. It is understood that the American governments plan something comparable to a coalition government to be guided and directed by a resident agent representing the other republics. This government is to police the country by means of a constabulary controlled by foreign officers. How far it may be possible to carry out this plan is, as yet, uncertain, but it is notable that the plan contemplates intervention in the name of Pan-America rather than by the United States alone. It is believed that this will be more acceptable and will make for permanent peace, perhaps all the more because Mexico once recognized the validity of such action by joining the United States in pacifying Guatemala. One of the benefits of joint action is that it will make possible an absolute embargo on the importation of arms and ammunition.

RUSSIA.—The Sissert will present a good report to its stockholders in a few days. We understand that recent drilling at the Degtiarsky has been eminently successful and has added materially to the 1,084,000 tons of 3% ore we reported in March. In fact, what amounts to a new mine has been developed, though, despite the 8000 or more feet of diamond drilling that has been done, only a part of the large estate belonging to the company has been explored.

The issue of the report of the Kyshtim Corporation for 1914 and the meeting of shareholders are postponed until October, owing to the impossibility of holding the annual meeting of the Russian company until August. The output and sale of copper was lower during the year than for 1913, the figures being 7971 tons and 7554 tons, and the profits were £90,000 less. It is estimated that the earnings will be sufficient to pay a dividend of 15% as compared with 25% the year before. An interim dividend of 5% will be paid directly financial conditions permit.

JAPAN.—Further expansion of zinc smelting in Japan is forecast in the announcement that the Mitsui Bussan Kaisha, the ore-buying firm of the well known Mitsui & Co., has contracted for the ore from the important mines near Vladivostok. This ore formerly went to Germany for treatment. Samples tested in the United States were found to contain more lead than was desirable, and so the contract goes to Japan. Mitsui & Co., owning the Kamioka mine, erected a smelter at Omuta, near coal mines and coke ovens belonging to the same firm, a couple of years ago. Having now overcome original difficulties, the firm is well prepared to treat the Siberian concentrates and will, it is announced, increase its plant for that purpose. Japan affords a considerable market for spelter and local brass makers have been hard hit by high prices.

BRAZIL.—New regulations governing prospecting and mining on both public and private lands in Brazil, since January 6, are now available in English. The provisions cover one-year prospecting licenses followed by 30-year concessions on public lands and methods of appropriating mining rights on private property. Payment is to be in the form of a small area tax and royalties up to 6% of the net profit. Administration and inspection is provided under the direction of the Geological Service, with an advisory council. Free importation of machinery and other important rights are conferred under appropriate restrictions.

CHILE.—In a previous issue we mentioned that Mr. William Braden had gone to Chile to develop a new copper deposit. A New York company called the Andes Exploration Co. has acquired this property, and it is stated that the funds are supplied by the Anaconda people. The deposit is at Portrerillos, 50 miles southeast from Pueblo Hondido, which is connected by railway with the port of Charanal in the province of Atacama, 180 miles south of Antofagasta. It is in an entirely different district from the Braden copper mine, being 500 miles due north. The Andes Exploration is also investigating properties in Bolivia and Peru, and it is anticipated that the Anaconda company, America's greatest individual producer of copper, is at last to turn its attention to foreign development.

MALAY. — Owing to some of the shareholders not paying their calls, the Ipoh Tin Dredging Co. was unable to meet the last instalment of the bill for the dredge, and was obliged to execute a mortgage on the whole of the property in favour of Werf Conrad, the builders of the dredge. Arrangements have now been made with the Borneo Company, Limited, on terms which virtually amount to a transfer of the mortgage. The Borneo Company will also advance working capital and will act as managers. The dredge has been completed and will be at work in a short time. Its capacity is estimated at 60,000 cu. yd. per month.

NORWAY.—Ice is thick in the Arctic this year, worse than for many years. The first two ships sent out by the Arctic Coal Company were stuck in the ice at the middle of July, and the winter crew was then still icebound at Spitzbergen.

NOTABLE DEATHS.—Since we last wrote the mining industry has sustained a severe loss in the death of J. A. Holmes, the energetic director of the United States Bureau of Mines. He was more than the director of that bureau; he might fittingly be called its creator, for he, more than any other man, saw the need and organized public opinion so as first to found the Technologic Division of the United States Geological Survey, and later to cause it to be made the nucleus of the larger organization. He directed the work toward the essential matter of saving life and material and gave it a strong impulse in both directions. As an example of the ingenuity of his methods may be mentioned his equipping of the first railway cars with rescue crews to travel to the mines in case of accident, and to serve as instructors between while. The system now covers the whole of the United States and is being introduced elsewhere. Holmes' own training had been in geology. Though educated at Cornell, he was a Southerner and he served as state geologist of North Carolina and professor in the State University a number of years. His success was due to his tremendous energy and his winning personality. He made others see his visions and help him attain them. He died, 55 years of age, from overwork, and was as surely a sacrifice to duty as any of the brave men now dying on the battlefields.

EDITORIAL

"NE'ER take a wife till ye ken what to do wi' her" may be quoted as a bit of philosophy worth keeping in mind when tempted to load up with options.

QUEBEC province is now the possessor of the no-man's-land, formerly known as Ungava, and has erected it into a territory under the name of New Quebec. As a first step towards its development, Mr. Theodore Denis, the superintendent of mines, printed a compilation of existing geological and mining knowledge of the area, which has now had to be issued in second edition. A glance at the great white spaces on the map emphasizes how little is known of this old old country and sets one dreaming of the possibilities that remain hidden in the region of "the nameless men who nameless rivers travel."

NICKEL, while mined principally in Canada, has been exported in matte and refined in Great Britain and the United States. The Canadians have, not unnaturally, long wished to see this business transferred to their own country, though the balance of informed opinion has heretofore held that the economies of the situation were against the transfer. The Ontario government is about to reinvestigate the matter, and has called upon Mr. George T. Holloway to serve as chairman of the investigating commission. We have no doubt that, whatever may be the recommendations of the commission, one result of its work will be a highly interesting technical report.

BUTTE, in Montana, is booming as never before, high prices for both copper and zinc filling the local cup of joy to running over. The Anaconda Copper Mining Company is reaping the reward of its fearlessness in continuing experimental and construction work regardless of temporary low prices. The boom came even before the reconstruction was completed, though the latter was carried out at the rate of one 2000-ton unit rebuilt every 30 days. As the work involved rebuilding even the foundations, this is notable in itself. Both leaching and flotation mills are now running successfully. We speak elsewhere of the flotation. The leaching plant is making a tailing of but 0·09% copper and on sand does a little better than flotation. The process is not, however, available for treating slime.

AMONG methods for meeting the deficiency in spelter for brass-making, Mr. E. Ferraris, the capable director of Società di Monteponi, suggests a reversion to the ancient method of making brass direct from ore mixtures. Since the world long obtained its supplies of brass by this method, it would seem distinctly worth investigating. Mr. Ferraris has discussed the matter at some length in the May number of *Rassegna Mineraria*, printed at Rome, and incidentally mentions Percy's investigations of the subject as a good starting point for British investigators. Perhaps we do not always realize how far it is possible to work direct from ore to finished product. The Wetherill direct method of making zinc oxide, except for certain grades, has largely supplanted the older process of first reducing the metal. Similar principles obtain in making lead pigments by the Pitcher process, and others might be mentioned.

BELGIAN companies whose offices were moved to London as an incident to the war, have had enough difficulties to face without their burden being increased by attempts to bring them under the Alien Enemy Act. No one can seriously suppose that a company driven out of Belgium by the Germans is an "enemy person," and yet the Act has been so poorly drawn that the matter is under question by the courts. With that delight in phraseology as opposed to facts with which, we regret to say, the lawyer's training at times infects even our judges, one decision has been given to the effect that such companies both are and are not enemies. That is, people owing them money are not to be allowed to pay it to them because they are residents of a country in enemy possession; but debtors are not required to pay the money to a public officer, as in the case of German and Austrian companies, because the Belgian companies are not aliens. This interpretation, which to a layman is ridiculous, is being reviewed and in the end our Belgian friends will probably be allowed to transact their business in peace. In the meantime, such decisions may, as Mr. F. A. Govett remarked of another such, "be satisfying to the legal mind;" but to the layman they leave much to be desired.

THE careful summary of stoping methods and drilling problems on the Rand, written by Mr. E. M. Weston, will be read by engineers with great pleasure. Mr. Weston presents a problem rather than a solution, and the value of what he has written lies in his insistence upon changes in the minor details of everyday practice, as a basis for making that saving of a 'shilling per ton' to which all Rand managers aspire. It is much easier to dream of some revolutionary invention than to improve the uniformity of drill sharpening and tempering in your existing blacksmith shops, and it is much more pleasant to make blue prints of a highly efficient central power station than to re-organize and simplify the distribution of steel underground. Yet the big problem is, and always must be, in the mine. Too many companies waste pounds in the dark, and strain to save pennies at the surface. We believe Mr. Weston's studies of the present situation and tendencies deserve careful thought from his fellows on the Rand and we shall be glad to have further discussion. We venture to differ on one technical point. Contrary to reasonable anticipation, the speed of drilling does not vary directly with the cubic contents of the hole drilled. The exact rate is not known, though the Sullivan engineers, and perhaps others, have experimented to determine the matter. The character of the rock enters into the problem, as some rocks flake differently, and it happens in drilling as in shaft sinking that there are conditions under which large openings may be made in the same rock at the same speed and expense as certain others of smaller cross-section. On this and many other points there is urgent need of more light from experimental studies, and we join Mr. Weston in urging that a way be found to sustain them.

METALLURGISTS engaged in the general work of their profession would do well to become familiar with the Institute of Metals, the Transactions of which contain records of investigations covering a wide range of interest. In Volume XIII are to be found papers dealing with the effects of heat and work on the mechanical properties of metals, the micro-chemistry of corrosion, and on nickel-aluminium, copper-nickel-aluminium alloys, copper-aluminium, and copper-tin alloys. The comprehensive digest of current literature adds to the value of the volume. The Institute of Metals has been one of the successful societies. Established seven years ago, the advantages afforded were immediately recognized by both users and makers of non-ferrous metal products. Papers presented receive sympathetic and well-informed criticism, the best reward of an author. The duty of this magazine and of the Institution of Mining and Metallurgy ends when the metal has been mined and extracted from its ore. The scientific consideration of the metal thus produced in connection with its applications and behaviour is of equal importance. This branch of metallurgy forms the scope of the Institute of Metals.

"OF all debts men are least willing to pay taxes," as Emerson long since noted, but for our part we are persuaded that the greater part of the reluctance is due to general belief in the inequality of the burden. It is this, as we understand, to which the mining companies in Australia object in the new proposals discussed on another page by Mr. H. R. Sleeman, of the Whim Well Copper Mines Ltd. Since he wrote, the High Court has ruled that the act is constitutional and also applicable to Crown Leases. The only outstanding question is as to the interpretation of "unimproved value" when applied to developed ore. We fear that the new law will operate to discourage investment in Australian shares, mainly because it introduces a new complication and a new danger. Actually the tax does not seem likely to prove heavy, and, that property should pay at a higher rate when owned by one man rather than another, while sounding inequitable, is in accord with the present fashion of super-taxing large incomes. We note Mr. Sleeman's fears that taxing ore reserves will discourage advance development, a fear we once entertained ourselves. In practice, and with reasonable moderation as to taxing rates, it does not do so. The technical advantages accruing from a large ore reserve more than counterbalance. The real limitation is the interest charge on the money invested. The tax no more influences development than reluctance to pay insurance premiums prevents the building of houses.

Flotation Again.

Further details are now available regarding the sale of the Elmore flotation patents in America that we announced last month. It appears that the rights were purchased outright by a group including the principal copper mining companies in the United States that have not come to terms with Minerals Separation. It will be recalled that in our issue of March 1914, in reviewing the decision of the Privy Council adverse to the Elmores, we pointed out that "the Elmore patents of 1898 and 1901 referred solely to the original process wherein large quantities of oil were used to raise metallic and sulphide particles," and that their patents of 1904 introducing their improved method known as the vacuum process were not cited. We also mentioned the fact that the invention disclosed in the 1904 patents antedated the principal Minerals Separation patent. That these facts were not brought out at the trial was presumably due to mere legal tactics, but the immediate effect was to leave the way open to further litigation. To what extent our comment influenced the recent sale, we are not informed. Flotation has not as yet made much return to the various inventors concerned, and we may be permitted to rejoice that some substantial financial reward has come to the Elmores at least, who, as we have previously stated, have not in our opinion received benefits commensurate with their contribution to the technology of ore dressing. At the same time we regret that this sale apparently portends more litigation. Clearly, the Elmore patent rights in the hands of the wealthy and aggressive group now engaged in litigation with Minerals Separation, are in a very different situation than when owned by a British company weakened financially by prolonged litigation and the expense of pioneering a new process. In the recent hearing at Wilmington, it was testified that flotation, if adopted by one group of American mines concerned, would have made a difference last year of $17,000,000 in receipts, most of which would have been clear profit. Even the most modest royalty when such totals are concerned amounts to a sum, as was cynically remarked, "worth fighting for." Presumably the Elmore patents are to form a second line of trenches for our friends across the water. Replenishment of the Elmore war chest, too, opens the way to further litigation in Australia, where action against the Zinc Corporation was, it is believed, abandoned mainly for lack of funds. We have frequently expressed our regret that rights in so technical a process as flotation should be left to adjudication by non-technical judges. As every experienced litigant knows, chance and strategy, as well as right, enter largely into such decisions, though the matter is of the largest possible interest to the mining industry. It is one of the cases where direct friendly negotiation would seem more likely to produce an equitable division of profit, but apparently it is impossible to bring all concerned to one mind as to what is fair and just. As an alternative, we can only hope that a fundamental decision may be reached by the courts promptly. In the meantime, the technology and applications of flotation make rapid progress. We refer for details to our Précis, Special Correspondence, and other departments. As instancing the degrees of perfection already attained, we may cite the fact that the Anaconda Company, licensees of Minerals Separation, is now making a tailing loss of but two pounds of copper to the ton of ore, and is feeding to its flotation plant ore containing as little as 0·8%, equal to 16 pounds per ton. In the face of such satisfactory and practical conservation as this, the delay in introduction of the process incident to the litigation, can only be regarded as a calamity to the industry. Adequate rewards could be paid to all the inventors concerned out of the metal allowed to go to waste since the litigation began, and probably tailing losses are even now costing more than the expensive litigation still in progress.

Tanganyika Concessions.

Among the company meetings of the last month few were of more technical and human interest than that of Tanganyika Concessions Ltd., or 'Tanks' as it is familiarly known in the City. As in previous years the dominant figure at the meeting was Mr. Robert Williams, whose uncrushable optimism has survived some fifteen years of fighting for his favourite company. One could not but be thrilled by his reference to certain recent happenings on the West Coast as ending for ever one strong source of opposition. Indeed the report presented to the shareholders was most encouraging despite the fact that the war had broken down plans nearly completed for financing the Benguella railway, and the occupation of Belgium prevented shareholders from realizing any immediate benefits from the profits now being made by the copper mines. It will be recalled that the principal mines, including all that are now being worked, are owned by the Union Minière du Haut Katanga, in which 'Tanks' holds a 40% interest. The Union Minière has a small capitalization, and will need to pay profits on only about £1,000,000. It has already accumulated a considerable surplus from operations, which is rapidly increasing. It is fortunate in that its capitalization includes only about £600,000 in debentures, and it should be in a good position to pay dividends whenever peace permits the legal holding of company meetings and the resumption of normal business. In the meantime, the work at the mines goes forward satisfactorily. The ore reserve is being increased, as shown in our abstract under Company Reports, and steady progress is being made in increasing the output, as mentioned in our review of the month. The cost of the copper now being delivered in Europe is considerably above the estimate given to the London public by Tanganyika Concessions when that company was floated. It will be remembered that in 1910 we pointed out that the expectation of laying down copper in Europe at a total cost of £25 was not likely to be realized. Actually the present cost is a trifle under £40 per ton. Naturally a part of the difference is due to the extra cost of freight and insurance incident to war conditions as well as to the incomplete stage of operations. It is believed, and we see no reason to doubt the figures, that within a year the Katanga copper can be laid down in England at a cost of £34 to £36 per ton. It should be remembered that this refers to black copper and that a further charge for refining must be met to raise the grade and broaden the market. Normally this charge would be covered by £2 to £3 per ton. Now the spread between electrolytic and standard copper is as much as £12. It is too early to say what the final cost of Katanga copper will be. So long as only the high-grade ore can be treated and blast-furnace work with coke is necessary, a heavy fuel charge must be met. The final figures will depend materially on what Mr. A. E. Wheeler finds possible in regard to treating the 'low-grade' ore, here meaning ore containing 7% copper. Larger scale operations and more direct transport will have important effects, and in any event a large and profitable industry is assured, though there is still a big technical problem to be solved. Fortunately, conditions have changed materially since the early days of the enterprise. Technology has made large advances and the work is now under excellent technical control. The chances for fairly low cost seem excellent.

One of the most surprising and interesting features of Mr. Williams' report were the facts brought out with regard to the Benguella railway, which Tanganyika Concessions is building across Angola to Katanga. This ambitious undertaking has been a heavy tax on the resources of the company, as is inevitable when one undertakes to cross mountains and tropics with any railway line. At the end of April the road was operated to Kilometre 520 from Lobitos Bay, and the earthwork has been completed to Kilometre 601. This is in an undeveloped country and the railhead is, as it may be noted, still many miles from the region the railway was built to tap. None the less it is showing a substantial profit over operating expenses and is developing traffic likely to be permanent in character in the area already penetrated. This is a most encouraging feature and offers large promise for the future. Tanganyika Concessions is still in the non-dividend class of companies, but it evidently holds investments of large value and, so long as losses can continue to be paid out of the premium on shares account, the shareholders can well afford to bide their time.

Progress in Dredge Design.

It is a pleasure to print such interesting details regarding new mining machinery as those given by Mr. Charles Janin in his description of the two gold dredges recently built by the New York Engineering Company for use in the Philippines. The combination of a steam turbine generating station with electric driving is in line with the very latest marine practice. Such a power-set was placed on the marine collier *Jupiter* in order to realize, if possible, the maximum of efficiency in generation of power and propulsion of the boat and yet dodge the difficulties incident to the differences in rate of ideal speed of turbine and propeller. A gold dredge moves forward too slowly to need a screw propeller, but the advantages of individual drive for its many mechanical units are such as to warrant a similar conversion of steam into electricity. This is a far cry from the day when even well informed mining engineers seriously questioned whether electricity could be economically used to drive a dredge. The answer was that it had to be, since current derived from hydro-electric plants was the only sufficiently cheap form of power available in California. The resulting changes in dredge design in turn almost force adoption of electricity even where, as at Paracale, it must be generated by steam. Not, of course, that a steam dredge is not possible or even in appropriate situations economical, but the drift is in the opposite direction. The controlling factor in the case of the Mambulao dredge was apparently the expectation that other boats will be added later. In that event the advantages of a central power station are so great as to warrant providing for more dredges in advance. All this illustrates how the conditions of a particular field, and even of each enterprise, control, and should control, the design of the dredge that is erected. We have referred to this matter before, but it will do no harm to reiterate. Last month we mentioned the Benue dredge in Nigeria as one that had failed. We are informed that it illustrates especially well the point we are now making since it was originally designed and built for another property, being later used instead on the Benue ground, to which it was not especially adapted. Evidently this is an instance where if business conditions had permitted, the company would have done better to permit the dredge manufacturer to build with a view to meeting the special difficulties of the particular ground to be worked. It was a necessity, or a mistake of judgment, merely worth noting as bearing on similar cases in the future, and the result does not necessarily condemn the boat in question, which presumably would have done well if used as intended. A recent visit to several of the dredges of the Natomas company brought to mind forcibly how each dredgemaster had his own problems, as it also gave proof that variation in design, when supervised by careful and competent engineers, is the correct means of solving these problems. The first dredge visited was working on a river bar. The situation was one where, if the ground had been dredged in the ordinary manner, the resulting tailing heap would have formed an almost complete dam across the valley section used by the stream at high-water stages. The result would have been to force the water against the other bank, through a constricted outlet, with much loss and damage to agricultural lands. For this reason the Debris Commissioners long withheld permission to dredge the ground. The difficulty was met by providing a swinging stacker which permits the boat to deliver tailing to either side instead of only at the stern of the boat. The result is that the tailing is stacked in a series of parallel ridges between which are open canals for the passage of flood water. The weight of the stacker is counterbalanced by water ballast. By this simple change in design a considerable area of rich ground was made available. The second boat visited was working in ground in which there is considerable 'rusty' gold. An unmeasured amount of this has been passing unamalgamated down the sluices and into the pond. Recently a Neill jig, invented by Mr. James W. Neill for use on his own dredge at Snelling, California, had been set into one of the sluices and, on the basis of the saving made, it was estimated that approximately 80 tons per day of material, containing gold worth more than ten shillings per ton, could be saved. It needed but the installation of simple appliances to treat this concentrate, for which there was room below the sluices, to make this additional saving, and these appliances had already been ordered. The Neill jig, by the way, is an extremely effective and simple device, easily added to the equipment of a dredge and capable, as we believe, of wide usefulness, especially in connection with tin dredging. The third boat visited was one where there had been much trouble in clearing the buckets because of the presence of a sticky clay. Usually when dredge buckets do not clear it is because of faulty design, but it is not always possible to remedy this without seriously altering the capacity of the dredge. On various boats attempts have been made to solve the difficulty by the use of horizontal jets of water driven into the buckets as they pass over the upper tumbler, or even by means of mechanical scrapers which reach into each bucket in turn. At Natoma another solution has been found, two jets of water under strong pressure being directed upward into each bucket after it has been inverted. These streams are so directed from opposite sides of the well as to meet in the bottom of the bucket and are of such force as to clear out the last reluctant bit of red clay. We instance these three boats belonging to one company as illustrating how capable engineers may to advantage adapt a particular type of machine to meet special situations. One can hardly visit a dredge anywhere without finding similar, though possibly not equally important, illustrations of the advantages of special, thoughtful designing. The engineer cannot change the character of the ground he must mine. He can, and should, adapt his methods and his machinery to that ground. It by no means follows that there is not room for standardization among the various dredges of a fleet and possibly further. Where fairly uniform conditions obtain, as in the Yuba goldfields in California, it is feasible to economize in spares, reduce loss of time due to stoppage, and in other ways to increase efficiency by having boats of a single general type built say in two sizes. The engineers of the Natoma company are now engaged in reducing to one standard as many as possible of the individual parts of their boats and even with so large a fleet operating under such diverse conditions, it is found possible to do much along these lines. Extreme specialization in design and extreme standardization both have their drawbacks from a business point of view. The wise engineer consults the experienced dredge builder when planning a dredge, and the wise dredge builder relies equally upon the engineer for accurate knowledge of the special conditions to be met. Thus lies the road to success.

Engineers and Military Training.

In our April issue we discussed the advantages of introducing military training into the technical schools, both as a medium of teaching engineers discipline and as a wise preparation for war. The subject is one of such importance that we may be permitted to recur to it. The value of discipline is undoubted, but the means of inculcating it are limited. There is no one thing more needed both for war and peace than that readiness at once to subordinate one's self and to take responsibility that is the prime object of military training. Many people do not see beyond the first step and think of military training as inculcating only blind obedience. That is a most important element, but an officer who never learned also to command would be of little service. In the technical schools men are given the information necessary to command in industry, but there is no systematic training of the individual looking to the commanding itself. The young man is taught something of chemistry, physics, geology, and engineering in general, but if he learns anything of human nature, of the motives that move men and make them effective units in the industrial machine, it is almost by accident and certain to be only incidentally. In the ordinary technical school it is nobody's business to give this training, and there are no accepted methods of developing such talent in management as the students may chance to possess. The result is that in practice mine managers are constantly hunting for helpers with 'personality,' disregarding, if need be, superior technical knowledge. In the end the best manager may or may not come to the top, and in any event his way might be shortened and smoothed to the benefit of the young man in question. There can be no doubt of the value to the individual of military training. One needs but to contrast the looks of the young men in the ranks of the London regiments with his memory of the same men last year. They are physically better and they are intellectually keener. It will be one of the compensations of the war that the great majority of the men who do return will be much more efficient than when they went away. It is also true that the great military and naval schools of the world train men who become leaders whether they stay in their service or return to civil life. The time spent in drill and in the study of military matters does not seem to interfere with the progress of the cadets in general science and engineering, and in modern warfare engineering is all important. So true is this that today officers are being recruited from among engineers for all branches of the service. In the artillery it is mathematics rather than muscle that counts, and munitions are, if somewhat belatedly, recognized as equally important with men. In Great Britain, within the last year, it has been proved most magnificently that in a modern industrial state devoted to peace, it is possible to raise large armies in a comparative few months. The new units which have gone to the Front have also set at rest for ever all question as to the efficiency of the individual fighting man. A large army, however, needs many officers, and the work of even a company officer is not learned in a few months. It is at this point that the present system breaks down. What more natural than to provide engineering students with such military training as will enable them to take a place quickly in command of volunteer forces? Especially when, as we have suggested, the additional training is of the best as regards preparation for their ordinary peace duties.

The best proof of the feasibility of a project is to point to it in actual and successful operation and this we are fortunately able to do. The United States, as is well known, is devoted to peace and yet, thanks to legislation enacted in the midst of the great Civil War, the United States, in this particular, sets an example. In America education is a function of the individual States and not of the Federal Government. Nonetheless, there is in every state at least one 'College of Agriculture and Mechanic Arts', frequently a part of the State University, which receives liberal support from the Federal Government. Originally this was in the form of a land grant designed as an endowment, but this was long since supplemented by an annual subvention, the result being a series of institutions that are well endowed and well supported. One of the conditions governing the grant is that the young men attending shall be given military instruction, and the result is a series of training schools for officers in addition to the great national schools at West Point and Annapolis which furnish officers for the regular army and navy. At the state institutions the students are required to wear uniform and to drill, usually two afternoons a week, during the first two years of the course. This is now being supplemented by a week or more of training in summer camps, generally under officers of the regular army. After two years, service is optional, and in practice few take the work of the later years, except those who have won commissions. The local Commandant is an officer detailed for service from the regular army, but all company and regimental officers are chosen from the cadet corps. These officers receive commissions from the Governor of the state in which they serve and have an established place in the state military organization. In case of war they may begin service with the rank attained in the cadet corps. They are given supplementary instruction in tactics, strategy, and military history by the commandant, and they learn by exercising it the difficult art of command over men of their own age and social position. The State supplies the buildings and grounds necessary. The United States furnishes all arms and ammunition and pays the instructing and inspecting officers, while the cadets supply only their uniform. In view of the fact that fees in state schools in America are extremely small, the latter is no hardship. The number of young men undergoing this training is surprisingly large. At one state university with which we are familiar, a full regiment, a battery, a signal corps, and a hospital service is maintained. Some 2000 men in all are in training here alone, and the cadet officers get real experience in handling men in barracks, on the march, and in camp. Since these men graduate as do others, it follows that this particular school, largely devoted as it happens to engineering, turns out each year something more than a regiment of picked men of whom the privates have had two years training and the officers four. This is but one of 52 such schools, though not all are as large. These state schools are supplemented by 130 private military academies, in most of which the training is under officers from the regular army. As to the thoroughness of such training, it may be recalled that in the Civil War, Stonewall Jackson's army corps was largely officered by student cadets from the Virginia Military Institute. It is estimated that the men in training, with recent graduates of these various schools, now number more than 100,000 men, a large and valuable military reserve. Such men as go to universities and technical schools acquire training quickly, and marching for four years under the flag of the State and the Nation gives one a feeling of real partnership in both. It has recently been proposed to supplement the student training by annually giving 400 student officers a year of service with the regular army. We believe this plan of student training affords a good example which might well be imitated, and by making grants to existing schools, each Nation may raise up valuable reserves against the time of need, without Prussianizing itself.

Explosives for War and Peace.

The study of explosives is receiving the close attention of the mining man from two distinct points of view. In the first place, many of the men themselves have taken up the work of making explosives, shells, and ammunition, and others are serving with the artillery, the engineers, or in the line. Secondly, in the mines necessity for economy in the use of explosives is pointing the way to important opportunities for reducing costs. In our June issue we pointed out that the element nitrogen is usually taken to be the basis of the exploding power because of its inert nature and its readiness to release other elements from a combination. The value of an explosive depends on its containing an ideal mixture of a combustible and an oxidizing agent, the oxygen available in the latter being so easily released as to make the combustion extremely rapid or even instantaneous. By nitrating an organic compound, oxygen is introduced to the requisite extent for this purpose. Similarly it is the oxygen in potassium, sodium, or ammonium nitrate, and in other components of explosives that assists the rapid combustion, and the nitrogen its easy liberation. Other oxygen compounds, such as potassium chlorate, can be used instead of nitrate in making gunpowder or other explosives, for chlorine is also a weak holder of oxygen. They are not commonly used because of being less stable.

Explosives were invented for the purpose of warfare, and it was not until the 17th century that they were used for blasting rock. The first projectiles were of the incendiary type, various mixtures of pitch, oils, naphtha, and sulphur being ignited and thrown from catapults. The present employment of burning pitch and liquids in the trenches is only a retrogression on the part of the Germans, and not a new and original prostitution of chemical science. The many varieties of 'Greek fire' used by the Byzantine emperors, and later by Western European nations, were flaming projectiles. At about the year 1000 A.D. crude potassium nitrate, then called nitre or salt-petre, was added to the substance of these projectiles by the Arabs and Chinese. Roger Bacon in the 13th century was the first to describe, if not to make, gunpowder, which consists largely of potassium nitrate, with smaller proportions of charcoal and sulphur. This was the first real explosive. Oddly enough its application in warfare was deferred for a century awaiting the invention of a suitable gun. Records of shells or explosive projectiles date from the latter end of the sixteenth century, but safe and accurate work with them was not possible until about 1780, when dependable time-fuses were introduced. Shrapnel shell containing an explosive and bullets was first employed about 1800. An important advance in the application of gunpowder to fire-arms was the invention of the system of ignition by means of caps or small detonators. The discovery of fulminate of mercury by Howard in 1800 was an event of first importance, for its use not only simplified the firing of charges, but made it possible to explode materials subsequently discovered that could not be exploded by simple ignition. A French chemist, Pelouse, was the first to suggest, in 1838, the production of explosives by the nitration of organic substances, that is to say by treating them with nitric acid and so introducing molecules of the nitration radical, NO_2, in place of atoms of hydrogen. He experimented on cellulose in the form of cotton, but not discovering the right method of conducting the reaction, did not obtain satisfactory results. A few years later Schönbein, of Basle, succeeded in this, and he is usually considered as the inventor of gun-cotton. Sobrero, of Turin, who was previously an assistant to Pelouse, succeeded in nitrating glycerine. Nitro-glycerine has the disadvantages of being a liquid and easily detonated, and it was not until Nobel mixed it with kieselguhr, or infusorial earth, that it could be conveniently or safely used. Subsequently Nobel found that if a small proportion of nitro-cotton is mixed with nitro-glycerine a solid explosive is formed, which he termed blasting gelatine. Other organic substances that have yielded nitro-explosives are benzene, carbolic acid, toluene, and naphthalene, all hydrocarbons that are obtained by the distillation of coal. Nitrated carbolic acid is known as picric acid, and under the names of lyddite and melinite has been extensively used in shells. Tri-nitro-toluene is also employed for this purpose. These two explosives are used preferably to any other in shell manufacture, because, as they require very powerful detonators to produce disruption of their elements, shells containing them can be fired from cannon without prematurely exploding. It is commonly supposed that the Germans use tri-nitro-toluene because it is more powerful than picric acid. This is a misapprehension, for its power is not as great, and its preferential use is due to the fact that it is more stable and of lower melting point. Picric acid is relatively unsatisfactory, for it attacks metal, forming picrates, which are extremely dangerous. Both picric acid and tri-nitro-toluene have an oxygen content less than that required for complete combustion, and consequently picric acid is apt to evolve poisonous fumes when exploded, while tri-nitro-toluene leaves a cloud of unconsumed carbon. For this reason the German shells filled with tri-nitro-toluene are called Black Marias and Jack Johnsons by our soldiers. To ensure complete combustion, additional oxygen may be provided by incorporating ammonium nitrate in the charge. Another of the coal-tar explosives is tetra-nitro-aniline, which is said to be superior in many ways to picric acid and tri-nitro-toluene. More will be heard of it before long.

So far, we have referred only to the 'high explosives' produced by nitrating organic compounds. It is only in torpedoes, in shells, and in blasting the hardest rock that violent and instantaneous action is required. For propelling the projectiles of big guns and fire-arms, and for the majority of applications in blasting, the intensity must be moderated, and in coal-mining the temperature must be so reduced that no flame is generated. Moreover the explosives for guns and fire-arms have to be produced in the form of coarse grained powder or in cords, strips, or some other convenient solid form. For these latter purposes, Nobel produced a modified blasting gelatine, using a nitro-cotton of low nitration, and the British Government adopted cordite, a mixture of high-power gun-cotton and nitro-glycerine dissolved in acetone and mixed with vaseline. The American and German Governments have since adopted propellant powders consisting chiefly of nitro - cotton without any nitro-glycerine. For sporting guns explosives made of nitrated cellulose produced from wood, mixed with mineral nitrates, are employed. Cotton is used preferably to other forms of cellulose in making gun-cotton because it can be nitrated to a higher degree. In the manufacture of gun-cotton for torpedoes, the Germans require a supply of cotton, though it is stated that they are substituting tri-nitro-toluene. For making powder for the artillery and rifles, where a less violent explosive is required, it is possible to use other forms of cellulose such as wood. At the present time much discussion is raging with regard to the necessity for preventing the import of cotton into Germany. The situation created is not only technical but political. The Germans allege that they can produce propellant explosives without cotton, but we doubt their ability to make equally powerful powders with other forms of cellulose. The wish of our Government, however, to avoid unpleasant complications with the leading cotton - producing country probably has greater weight in their councils than disbelief of the German claims.

Two other groups of explosives require notice. One is based on the use of ammonium nitrate, to which is added combustible substances or explosives. The ammonium nitrate has a much lower temperature of ignition than nitrated organic compounds, and its addition to the high explosive results in the production of flameless explosives suitable for coal mines. The other group consists of the so-called Sprengel mining explosives, named after the inventor. The principle consists of making an explosive mixture on the spot of oxidizer and combustible. The only one in this group that attained notability was rackarock, which was used in the removal of Hell Gate, in Long Island Sound, New York.

The earliest records of the application of gunpowder to mining point to Schemnitz in Hungary as being the birthplace of that art. Its introduction into Germany followed early in the 17th century, and into Cornwall in 1689. For metal-mining purposes, high explosives such as blasting gelatine are too violent in action except when the rock is extremely hard and tough, and a great range of less violent explosives with a lower rate of combustion have been developed to meet the miner's requirements. Other improvements have been introduced for the specific purposes of preventing the exudation of nitro-glycerine, and of reducing the amount of nitro-glycerine and nitro-cotton, this reduction being effected for the purpose not only of delaying the action but of cheapening the product. In devising a mining explosive, it is of greater importance than in war that the combustion should be complete and no noxious gases such as carbonic oxide formed. An interesting series of modified dynamites was introduced in America, wood meal being used as an absorbent of nitro-glycerine instead of kieselguhr, and nitrate of soda being added, chiefly for the purpose of introducing the oxygen required to ensure complete combustion of the explosive. The great advantage of these explosives is that they do not contain any inert substance, as in the case of ordinary dynamite. At one time objections were raised in some quarters to the use of nitrate of soda, for its hygroscopic qualities were expected to introduce an element of danger, through the moisture absorbed displacing the nitro-glycerine and causing the latter to exude as a liquid. These objections have been removed by hermetically sealing the cartridges in waterproof paper.

We may suitably conclude this article by reminding readers that the wide variety of mining explosives now available and the differences in their characteristics afford opportunity for the intelligent study of their economical application. It would be well for mining engineers to make themselves intimately acquainted with the great range of explosives now offered for sale, and to see to it that the right explosive is chosen in each particular case.

STOPING METHODS AND DRILLING PROBLEMS ON THE WITWATERSRAND

By E. M WESTON.

Rand mining companies spend large sums to save 1d. or 2d. per ton on treatment charges, but are neglecting the possibility of saving 1s. per ton in mining costs by closer study of drill work underground. Even the right lines for development are not surely known and much experimental work is needed. Stoping costs have been cut in half elsewhere, why not on the Rand? The large importance of small differences in choice of drills, steel sharpening, and methods of work, is brought out forcibly. Practical suggestions for improvement are made.

WHAT are the best methods to be employed in breaking rock? This is and always has been the most important question on the Rand. In solving this problem lies the greatest hope of substantial decrease in working costs. Owing to the peculiar conditions on the Rand it is perhaps the hardest to solve of any mining problem. This subject is of paramount importance, and there is no doubt today that stoping is the department in which the greatest waste and inefficiency occur. Despite the something that has been done, and the attention now directed to the matter, there is a lamentable lack of knowledge of the subject and a need of scientific experimental work to establish a right body of doctrine and to point out right lines for advance. It is left for manufacturers to bring up schemes and machines for trial under more or less unfair conditions, and the real causes of failure, and the places where advance had been stopped by a blank wall, are not marked out. Who, for instance, would care to say boldly that for work in flat stopes of the future the path of advance lay in perfecting hammer drills rather than changes in piston-drill practice? In other countries, more especially in America, where the problem is somewhat simpler, the lines of advance have been marked out, and progress to the extent in some cases of halving stoping costs has been attained. But this was obtained only by scientific research and by calling in an army of trained observers, and with stop watches to supplement the work of mechanical genius. We need to know whether progress on a field like the Rand lies upon parallel lines, or whether the circumstances are so different that other means must be adopted. What we need first to be sure of is, what is the best and cheapest method, under the local conditions, of introducing the most suitable explosive into the rock to be broken, and how are we to introduce it so that its maximum effect can be obtained? Can we, by education or organization, modify local conditions to bring them into line with those elsewhere, or are the physical factors different and permanent?

RAND STOPING CONDITIONS. — Visits underground all along the Rand emphasize the fact that these questions are not answered. In general the stoping practice and efficiency are much below what is known to be possible, even under present conditions, and, with regard to further progress, there is a state of irresolution and disagreement on a number of important questions. If we ask what is the best way to break rock in large, medium, or small stopes, whether by large piston drills, large hammer drills, smaller drills of both kinds, or by hammer boys, under the same conditions, we meet different opinions. If we ask how many machines of various sorts a white employee can efficiently supervise, we receive different answers. It is true, of course, that conditions in dip, hardness, and character of stopes vary, but there is no body of doctrine to tell us just how much weight should be attached to such factors in attaining to a right solution of the problem. To arrive at any useful result the numerous factors of the problem must first be correctly set out and then their relative importance carefully weighed. Some are human factors and are hard to estimate. In a recent report of one of the mines it was stated that hammer drills had not so far been a success, because, among other things, the cost of sharpening and replacing hollow drill steel was just twice as much as it was with solid steel for piston drills. But is this decisive? What is this cost per machine shift or per ton broken with both types of drills? Does it more than counterbalance any advantage of greater footage drilled, which hammer drills may possess?

ELEMENTS OF DRILLING COST. — To conduct an inquiry into the problem as at present known, we need first to ascertain what are the separate costs involved in breaking rock and how they depend on one another and their relative importance. In using rock drills, we have first the capital cost of providing compressed air and conveying it to the working faces, the cost of providing a rock drill equipment and fittings, and a stock of drill steel, with facilities for its conveyance and sharpening. These costs should be spread over the total tonnage mined, allowing for interest and amortization of capital. In breaking rock by hand labour we have to provide somewhat more accommodation for labour, and a smaller amount in regard to equipment and drill steel; but in practice the rock drill costs can never be eliminated, as development must be carried on by rock drills, and fluctuating labour supply usually compels an almost similar amount being spent on plant and equipment as a stand-by against shortage of native labour. The running costs for breaking rock by machines will be: Cost of supervision, cost of white labour, cost of native labour, air costs, including cost of pipe-laying and of air hose, cost of explosives, cost of maintenance and sharpening of drill steel, rock drill repairs and replacements, and, as compared with hand labour, the cost of the extra stope widths involved by moving, sorting, and crushing more waste broken with greater shock to overlying strata, as against relatively cheaper breaking with larger stope width and a better supply of material for packing.

I need not enumerate the fewer items of costs involved in hammer work. If stoping be carried out on right lines it should follow that the amount of rock broken per shift increases as the footage drilled, so it follows that the most valuable asset in any machine drill is undoubtedly maximum drilling power, because the total of all costs worked out on 'per foot drilled' or 'per ton broken' is decreased as this increases, as it is a direct division of them. This maximum drilling power is not necessarily maximum drilling speed, but may be expressed as $S\left(\frac{t}{t'}\right)$ in which S = maximum drill speed, t = drilling time, and t' = total time of shift. Obviously it is no use having a machine that can drill six inches per minute if, owing to the difficulty in handling it, owing to breakdowns, or to the fact that it blunts or breaks drills quickly, it is drilling at its proper speed only one hour per shift against two or three hours of another slower and more reliable machine. The next desirable qualification of the ideal drill is, that it permit boring holes placed so as to be most effective in removing rock and breaking it with the least expenditure of explosive at a minimum total expense per foot drilled. This can be done in two ways, first, as already pointed out, by spreading the total cost over as large a footage as possible, and, secondly, by reducing those costs by economizing in labour, air, repairs, drill steel, and supplies. It requires sound judgment to know to how great an extent we can safely increase any one of these items to procure a given rate of increase in drill speed, and just how much we can safely reduce any of them if that reduction has any adverse effect on drill speed.

The cost per foot drilled may be determined by the formula

$$C = \frac{L + A + R + S + S'}{DS}$$

in which

C = cost per foot drilled
L = labour lost
A = air cost
R = repair cost
S = steel cost
S' = supplies cost
DS = drilling speed

We have to strike a wise balance in every direction. If we increase nominal drilling speed too greatly we are sure to increase the cost of repairs and for drill steel; and the very fact of these being increased will nearly certainly mean that there will be more breakdowns, more delay during the working hours, and, consequently, loss of drilling time and drill power. It would then be a mistake to endeavour to attain high efficiency or low expense by paying too much attention to one factor at the expense of a more important one. Under the mining conditions prevailing on the Rand today, however, efficiencies react on one another. For instance, the air pipes that supply drills at various working faces are often far too small. The use of a fast drilling machine that required a large consumption of air would in those circumstances cause a great amount of friction and loss of pressure in the air pipes, and the drill would be supplied with an insufficient amount of air at a pressure too low. It would fail to realize its proper speed and would be inefficient; whereas a drill very economical in the use of air but with lower nominal drill speed would prove efficient.

There is another aspect of the question that cannot be ignored when discussing drilling speed. I have assumed that extra footage drilled or the power to drill extra footage means increased tonnage of rock broken. This does not by any means hold true in practice, and this complicates the question. We need with our ideal drill that during its working time it should drill just the right length of hole to be most efficient, and that it should be able to drill the hole in such a way that each has on it, and is able to break, the greatest burden that the maximum amount of explosive which can be economically placed in it will move. In developing on the East Rand, for instance, it was repeatedly proved that a $3\frac{1}{4}$-in. drill could put in six or seven 6-ft. holes, including a dry hole. Yet, in stoping drilling, with wet holes only which are quicker to drill than dry holes, we have but four or at most five drilled. Some of the reasons no doubt lay in less attention being paid to preparing the working place beforehand, but the real cause is that the type of bar and arm used being the same as that used in development, the miners did not know how to drill to any greater advantage.

SHORT VERSUS LONG HOLES.—Consider how little the question of drilling more short holes against fewer long holes with piston or other drills has been studied, because the type of rig in use forced one method. Drilling speed varies nearly inversely as the area of the hole bored, or, in other words, it costs about the same in time and air used to excavate one cubic inch of rock as another. Except for the time lost in adjusting a drill and starting a hole, in the time during which one 8-ft. hole is drilled (drilling 2 ft. each with bits $2\frac{1}{4}$ in., 2 in., $1\frac{3}{4}$ in., and $1\frac{1}{2}$ in. diameter) we could drill nearly three 6-ft. holes (drilling 18 in. each with bits $1\frac{3}{4}$ in., $1\frac{1}{2}$ in., $1\frac{1}{4}$ in., and $1\frac{1}{8}$ in. diameter) or more by using $\frac{3}{16}$ in. difference of gauge, which would be ample. We could also drill instead five 4-ft. holes, starting $1\frac{3}{8}$ in. and drilling one foot with $1\frac{3}{8}$ in., $1\frac{1}{4}$ in., $1\frac{1}{8}$ in., and 1 in. bits each. Except, perhaps, in the case of stopes with large free faces, no convincing reasons can be given for confining the drilling to long holes with a large diameter at their bottom.

Do we know just what are the factors that do or do not render it uneconomical to take down a small $2\frac{3}{4}$ in. stope drill and place it on another bar and arm which we could arrange to have rigged on another bench ? Would it be possible to train whites and natives to an entirely different style of work ? Would it not be wise to find out what are the precise conditions, including height of stope, dip of stope, character of ground, interference of one hole with another, style of rigging up, and portability of machine, that make it wiser to drill one long hole against 2 to 5 shorter ones ? One large hole will be or should be more wasteful of explosive than blasting using smaller holes. The amount of explosive needed varies as the square of the burden, and a hole with 3-ft. burden requires about nine times the explosive charge as that with a one foot burden. If we decide that it would be more economical to drill numerous short holes we must decide to adopt some way of doing this so that the holes do not interfere in any way with one another, that is that they do not spoil one another by breaking short, failing to come, or do not tear the burden off other holes, leaving their explosive to be wasted. If we decide that it is impossible to induce miners and natives to drill on two benches we need to ask if there be not a better way of rigging a machine for stoping than by using the same arm and bar as is used for development where the work is quite different, and if there is not a system of drilling holes that will enable a number of holes to be economically and quickly drilled from one bench. As a matter of fact, the prospect of a big advance lies along these lines, combined with a system of rigging machines before the actual drilling shift comes.

SKILLED AND UNSKILLED LABOUR.—There is another characteristic the ideal drill should possess for work on the Rand. Its manipulation should demand the minimum amount of intelligence and skill. This is essential. The drill must be as simple as possible, since natives have to do the actual running of it. This is, of course, not because it is not economical in all such work where expensive materials are employed to pay for and obtain the highest intelligence and skill procurable. If this lesson has not been learnt here it has been learnt in all the efficient countries of the world. There are no reduced costs or extra profits to be gained by reducing the rewards and incentives to the use of extra intelligence and skill, but the trouble is that the necessary skill and intelligence to work complicated machines for stoping is scarce or absent. The large and medium sized piston drill is a simple machine, and though his work is slow and inefficient unless under a skilled and vigilant white overseer, yet the Kaffir can and does run it fairly well. This is scarcely so with some types of more complicated hammer drills. The native requires closer supervision. The labour cost per fathom stoped is made up largely of the cost of white supervision, and the simpler a machine up to a certain point the more the cost of supervision may be spread over a number of machines. I am aware that this policy if carried too far may tend to defeat itself by lowering the drilling power of the various units, and I am afraid in certain cases it is being carried too far. With small water-feed hammer drills, which theoretically could be worked by one native, it was found that the drill speed could not be realized with one, and that in practice even more natives were required than with piston drills, and the white miner could supervise fewer of these machines than piston drills instead of more. This does not say that there may not be a design of hammer drill in existence or in preparation that will not prove a one-man drill easily supervised.

LABOUR COST.—In two mines of the Far East Rand working under good conditions the cost of white labour is about 12s. per fathom or 10d. per ton. In a deep level mine running more small piston drills than large drills in stoping, the cost rises to 17s. per fathom, and the cost per ton broken to 2s. 4d. per ton. In another similar mine the figures are similar, but in another, where a large number of $2\frac{3}{4}$ in. piston drills are employed, they drop owing to the distribution of white labour over more drills to 11s. 6d. per fathom, and to 1s. 3d. per ton, and in another large property using some hammer drills for stoping the cost is 13s. 6d. per fathom and about 1s. 4d. per ton. Native labour in the East Rand mines costs under 6d. per ton, but in the other mines mentioned it varies from 1s. to 1s. 10d. per ton.

COST OF AIR.—The cost of compressed air per large $3\frac{1}{4}$ in. rock drill shift varies considerably, depending on the efficiency of the compressor supplying it and the state of the pipes. On a large scale the cost of its production has been greatly reduced, and the average pressure supplied is maintained at a higher level in many mines. The cost of compressed air per shift will for large $3\frac{1}{4}$ in. machines be somewhere about 8s. per shift, being lower where air is cheaper. It may be taken that a rock drill like the Konomax, which achieves the limit in possible air-saving, represents a saving of 2s. to 3s. 6d. per shift. If a large rock drill breaks 8 to 14 tons per shift then the cost of compressed air would be somewhere between 6d. and 1s. per ton. The possible saving by using air expansively or by drilling smaller holes with smaller machines would be from about 2d. to 5d. per ton.

COST OF EXPLOSIVES.—This is least with hand-drilling, more with small stope drills, and greatest with large machines drilling holes with larger burdens, as should be expected from the law governing the action of explosives. In the easy ground of the East Rand the cost is 12s. to 13s. 9d. for large machines per fathom broken, and 8s. 9d. for small machines. The cost per ton, however, in each case is just under 1s., which indicates poor efficiency for the smaller drills. It is 9d. per ton for rock broken by hand labour. In the harder ground and more difficult and steeper stopes of the Central Rand, explosives cost from 14s. 6d. per fathom where numerous $2\frac{3}{4}$ drills are employed to £1 per fathom, the cost per ton rises from 1s. 7d. to, where separate figures for large and small machines are not available, 2s. 10d. for large machines in a mine where stoping presents difficulties. In another mine, where a number of hammer drills are run with small piston drills, the cost is 15s. 6d. per fathom, and the cost per ton 2s. 4d.

The explosives used per fathom in hammer stopes is as low as 6s. per fathom on the East Rand, as against 12s. for large machines, and all over the Rand runs from 9s. to 11s. per fathom on a stope width of 52 to 65 in. These figures go to show that the tremendous variations in cost of explosives on the same mines for machine stoping are not normal, and depend on other things than the character of the ground.

The average stope width for large machines in the instances mentioned is about 70 in., for small machines 57 in., and for hand labour 58 in. One fact stands out strikingly in any review of Rand mining costs today with a view to their reduction, that results obtained by hammer work show that if we could conduct our machine drilling to some extent on the same lines there is a possible saving of 6d. to 10d. per ton on explosive used. This is certain, not only on theoretical grounds, but is proved by the fact that on some mines where this work is more efficient better results than the average to the extent of 6s. per fathom have been gained. It would, however, be a mistake to assume at once that the line of progress necessarily lies along such lines. Explosives are only one item of costs, and if the total production of tonnage per shift can be increased by using a few more pounds of explosive the costs per ton will be automatically reduced to a greater extent. We need to see the way to reduce explosives without reducing any other efficiency, and, if necessary, to be prepared to spend more on this item if we can reap adequate benefits from it. Nevertheless, it is obvious that great savings are possible in this item.

THE COST OF DRILL STEEL AND ITS MAINTENANCE.—This is a more important item as regards the relative efficiencies of hammer and piston drills on the Rand than elsewhere. When the ground is in any way soft, as in the Kimberley diamond mines, hammer drills for most work at once prove their superiority. On the Rand it has been stated that this represents twice the expenditure of solid steel for piston drills. This in itself is no large item, but the matter does not end at this. Hollow steel is harder to sharpen and to temper correctly than solid steel, and the majority of the blacksmiths on the Rand are either not given the time or have not the skill to do this well. In America and on the Continent of Europe this matter receives the attention of technically trained men, and is given the attention of its importance. No mining house has used the services of a real expert to lay out a scheme of work and supervise it. They do this and acknowledge the necessity of it if it be a matter of saving 1d. per ton in cyanide costs, but in the vital matter of breaking the ore it does not seem at first sight to be necessary.

In all cases I have examined, work goes on by rule of thumb, the great object being apparently maximum output in minimum time. With hollow steel there is always a far larger number of imperfectly tempered drills than there is with solid steel, and this directly affects the efficiency of the drilling work of the hammer drill. Then, again, not only does the drill bit in most cases require special care in tempering, but the shank of the drill gives greater trouble, as it has to resist the blows rained upon it by the hammer. The difference of gauge between bits is often gradually made greater to allow for bits that are soft or which chip away, and the hammer drill is called upon to excavate much more rock than was anticipated at first. Its drilling rate naturally falls off. Machine sharpening has in this respect a great advantage. Again, it has been proved that on the Rand in ordinary hard ground the blunting and wear of steel in hammer drill holes is nearly double that of steel used in piston drills, and instead of the difference in length of drill steel being two feet, as in piston drills, it is only one in most hammer drills. This means that, in order to drill the same length of hole, twice as many separate lengths of steel have to be transported and sharpened, there is twice the risk of finding a badly tempered bit, twice as many shanks to suffer damage, and the weight of steel required to drill a hole is greater. The cost of sharpening solid drill steel in one mine where the ground is comparatively soft, and the drills used nearly all $3\frac{1}{4}$ in. machines, is only 1s. per machine shift, or about 1d. per ton broken. In a Central Rand mine, using about half $3\frac{1}{4}$ drills and half $2\frac{3}{4}$ in. drills, the cost is 11d. per shift or $1\frac{1}{2}$d. per ton broken. On two mines, where the stoping efficiency is low, the cost per shift is 15d. to 18d. and 2d. to $2\frac{1}{2}$d. per ton broken. On these mines 18 to 27% of the machine shifts were with hammer drills of various kinds.

On one large mine, where nearly 50% of the machine shifts worked were hammer drill shifts, including at least some 10% of hammer drill shifts using hollow steel, the cost was 24d. per shift or $2\frac{2}{3}$d. per ton broken. If we estimate extra cost and extra wastage of hollow steel at another 1d. to $1\frac{1}{2}$d. per ton, the whole item is after all a very small one. On the Robinson Deep the cost of sharpening and replacing drill steel is stated to be 6% of the total stoping cost of about 4s. to 6s. per ton. It is evident that if we could make sure that the hollow steel was so well sharpened as to be efficient, and if only a small increase of drill speed and rock broken was attained, we could easily afford to spend 3d. to 4d. per ton in sharpening drill steel. For stoping work, however, apart from development, the line of advance lies in using hollow steel in hammer drills rather than solid or hollow steel in piston drills. One may still ask, however, whether further progress with piston drills is really impossible and whether we are getting all the efficiency from them we should? Are we using solid steel to the best advantage in ordinary piston drills, and is there not still scope for improvement? Some time since the mining industry spent several thousand pounds on an investigation of drill steel. The investigator, after exhaustive experiments, made a number of recommendations. He recognized the supreme importance of having drill bits 'true' in every particular, so that not only should the shank be in a straight line with the axis of the piston, but that the outside edges of the bit be included in a true circle. This is a cause of serious power losses and loss of time, and destroys efficiency. He recommended that hand sharpening practice be modified so that every drill steel be passed through a proper gauge circle while sharpening, insuring that it be round and that the correct gauge be given. Such a change would increase the cost of sharpening a few shillings per hundred drills. The benefits are undoubted, yet no attempt has been made to adopt the recommendation. It is, fortunately, true that machine sharpening has since been introduced to a large extent and has remedied the defect, but there is a great deal of sharpening still done by hand in which the gauge is judged only by the eye, and there is no doubt that inefficiency is caused by untrue and badly gauged bits. There is another glaring cause of inefficiency which no one has hitherto dared to tackle, because its importance has not been appreciated, and the difficulties in the way of remedying it seem great.

VARIETIES OF STEEL NECESSARY.—It is a grave mistake to use the same drill steel for boring dry up holes as for use in the ordinary wet holes. Under present conditions it takes nearly one working shift to put in an upper hole in some of the harder mines with solid steel in development work, and largely for this reason hammer drills are being introduced with success. Practically nothing has been done to endeavour to improve the efficiency in drilling up holes and at the same time to increase drilling speed in down holes. There is a fear of introducing further complications in the already often badly organized department of drill supply and distribution. This is a very real and difficult problem, but underground sharpening stations and machine sharpeners are doing much to simplify it. At the present time all steel for large drills is cut with about 2 ft. difference of length and a difference of gauge of $\frac{1}{4}$ in. Sometimes the difference between starter and second is more than this, to allow of the extra wear in starting a hole. It may be argued that under present conditions a back hole should be drilled with water supplied to the end of the hole, and that the excessive wear and blunting of bits drilling any holes is unnecessary. Unfortunately, the fact remains that though some miners do now use a water jet of some kind to drill the first foot or two, many do not do even this. It is only under the somewhat exceptional condition of having the water pressure right and both hose and jet in excellent condition that a back hole will be drilled wet. The thin Mannesmann steel and copper piping used for this soon gets damaged, and the natives on the slightest excuse cut the hose and throw the jet away. The native does not want to use water or get wet, and the miner usually will not compel him to do more (if he does that much) than to squirt water at the mouth of the hole to kill dust. The best will in the world on the part of supervisors and mining inspectors is powerless against apathy or opposition of all labour. So the fact remains that most back holes are still drilled dry, and this means that the steel quickly heats up, the bit loses its temper and is quickly blunted, powdering up its own cuttings. It is ridiculous to expect a drill to stand for 20 or 24 in. under these conditions. The blunt drill is merely bumping and crushing the rock, instead of cutting it most of the time, and the miner has difficulty even with $\frac{1}{4}$ in. difference of gauge in getting steel to follow. Pressure is put on the drill sharpener to make the difference even greater. In any case the difference of gauge designed for drill holes causes an almost incalculable loss in drilling wet holes, because in these holes the rock drill has to excavate 10 to 20% more rock than is really needful. This alone means reduced boring speed and the loss of many rounds in development where the miners have just failed to get through.

SUGGESTED MODIFICATION OF WORK.—I would suggest the following modifications in practice. I would provide separate sets of drill steel separately sharpened for boring dry holes. To distinguish them at once from ordinary drill steel I should make them solid, without welding, and of suitable sizes of star section steel. They could be easily procured twisted to form a rotary conveyor to pass cuttings down the hole. I should make the lengths of different steel differ only by 12 in. with $\frac{1}{8}$ in. difference in gauge of the following steel with perhaps variations to suit the ground. The first result of the change would be that upper holes in hard ground would be drilled in half the time. The second effect would be that it would be at once possible, I believe, to cut down the difference of gauge in the steel used for wet holes to $\frac{1}{6}$ in. or $\frac{1}{8}$ in. for anything like average ground, certainly for most Far East Rand ground. This would mean that instead of a set of steel being $2\frac{1}{4}$ in., 2 in., $1\frac{3}{4}$ in., and $1\frac{1}{2}$ in. for a seven-foot hole, we would use 2 in. or $1\frac{7}{8}$ in., starter, $1\frac{3}{4}$ in., $1\frac{5}{8}$ in., $1\frac{1}{2}$ in., and this would mean that the amount of ground excavated would be reduced 20% with corresponding increase in drill speed, or if necessary a greater number of smaller drills could be employed. Where the rock is hard $\frac{3}{16}$ in. difference should be ample, or better still in this case, the difference of lengths of steel be cut down to 18 in. with about $\frac{1}{8}$ in. difference of gauge. To realize these benefits more attention must be paid to sharpening. In this connection the experiments conducted by Mr. Robert Allen for the Mines Trials Committee in 1910-1911 are most interesting. He showed that by adopting a proper system of gauging bits when being sharpened by hand and by forming the bits in such a way that reaming edges were formed on the outside of the wings, even with chisel bits 24 in. of hole could be drilled in hand stopes of the Robinson Deep with a loss of gauge of only about one-sixth of an inch, and no doubt better results would have been obtained with star bits. This proved conclusively that it is practicable to make the reductions here advocated.

I think that something of the success gained by some hammer drills is due to the fact that the users of them have been compelled to cut down the difference between drill steels to 12 or 18 in., and this means, other things being equal, that these drills do more economical chipping of rock at the bottom of the hole and less bumping and crushing.

CLEARING THE HOLES.—Any increase in drill speed of hammer drills over piston drills is no doubt theoretically due to the greater energy which can be imparted in a given time to a cutting edge by the greater number of blows delivered per minute in that form of drill, but it is also due to the fact that the system of passing water or air and water to the cutting edge does, in any except fairly steep down-holes, remove the broken fragments of rock more quickly and prevent energy being wasted in crushing them further.

The question arises, can the work of piston drills in drilling down holes in stoping be improved in this respect with any hope of gaining a notable advance in efficiency? There have been many attempts made to employ hollow steel in piston drills to drill back holes, and there is at present a machine of this type being sold in America which has done very good work in tunnel driving, and there are feasible though expensive methods of doing this with drills of ordinary type. However, the wear and tear owing to the hard ground and the lack of skilled supervision for their operation makes it at present improbable that any type of piston drill for drilling wet upper holes can be evolved to compete successfully with hammer drills for that purpose.

In drilling down holes with solid steel in a piston drill, the cuttings are subjected to a lot of re-cutting, to the detriment of drill speed, though they are surely and efficiently removed when small enough. Experiment and observation have, however, shown me that the whole theory of the design of rock drill bits as expounded in books and drill makers' catalogues is wrong. In them the point most insisted on is the necessity of allowing ample clearance between the wings of the bit for the ejection of cuttings. It was an Australian miner who first showed the absurdity of this arrangement. It is obvious when we consider it that the more we make the bit into the shape of a piston with small openings for the escape of water and cuttings, the greater will be the compression of the mud on the forward stroke and the more violent the ejection of cuttings. If six-pointed bits be employed in piston drills, an increase in drill speed is at once apparent. With hand sharpening it would have been too difficult to form such bits from solid round or octagon steel. Now, however, with machine sharpeners it is easy. This suggests a possible line of advance with the use of hollow steel in the smaller piston drills used in stoping. If the piston bit be formed and if the bottom of the chuck be bored out to provide escape for the cuttings, these in the form of mud are ejected in a most violent manner as soon as they are broken and they are not pounded up at all. The drilling speed is thus greatly increased. The way is opened for improvements in several directions, as no patents block the way. For instance, it is quite feasible to use $1\frac{1}{4}$ in. steel with a hollow core a half-inch in diameter, or $1\frac{1}{8}$ in. steel with $\frac{3}{8}$ in. hollow core, or 1 in. steel with $\frac{5}{16}$ in. hollow core. This means that the rock in the centre of the hole would be drilled round to form a core and broken off in large pieces, reducing the cutting necessary. Very little delay due to the central hole clogging is ever caused, and when $\frac{1}{2}$ in. or $\frac{3}{8}$ in. in diameter it never stops up.

Provided machine sharpening is adopted, a much improved and stronger type of drill bit, with an outside reinforced circular cutting edge, can be employed. These promising developments could not be followed for some time owing to patent rights, but these have now lapsed. I was recently able to carry out experiments on a small scale with the best results. I had everything ready for a larger scale test under working conditions, but unfortunately the opportunity was taken away from me before I could produce working figures. The difficulties of carrying out and superintending such experiments while acting as a mine official are, however, very great. Bitter experience has shown me that any new development, however good, must be introduced gradually under one's own direct control with picked workers, who must then be employed to train others. Otherwise defeat is a foregone conclusion.

One thing is, however, certain, apart from any such possible developments as have been sketched out. On the East Rand, for instance, with the present type of machine and steel, a small stope drill can drill 6 to 7 six-ft. holes in one shift if too much time is not spent moving the drill; generally such efficiency is not being obtained. It can, however, be obtained by taking suitable measures; hence, in stoping practice, there seems yet no call to install machines of higher maintenance and operating costs, because the nominal drill speed may appear higher. Let us first find out the reasons for the inefficiency that exists and remedy it.

VALUE OF BETTER SHARPENING.—One general result, I think, emerges from this rather lengthy discussion. It is that progress in drilling must involve greater expenditure in the maintenance and sharpening of drill steel, and that the cost per ton of efforts in that direction, in comparison with possible gains in drilling speed, may be disregarded. I cannot, however, leave this subject without drawing attention to another striking example of the neglect of the conditions necessary for efficiency. I have written already on the necessity for anything like efficient results that the drill bit should be in a straight line with the axis of the piston. Assuming that the chuck and bushing of the rock drill are maintained in a proper condition, we must remember that nearly all drill bits are made by welding, and their straightness is judged by eye only. Drills are continually being bent, and these again are straightened on an anvil by the most primitive methods. It is no exaggeration to state that the majority of drill bits now in use are not straight. There is no regular and systematic test to ensure that they are straight. The reason probably is that it would take time and money and the necessity of such a thing has never been considered.

REPAIR, MAINTENANCE, AND REPLACEMENT.—Repair and maintenance, excluding cost of new machines, is generally given on a monthly basis. It varies from about 95s. 6d. per month in the case of a mine working large machines in comparatively soft ground to 210s. on a mine on the Central Rand working a large number of small machines. The cost per ton will vary from 3d. to 10d. per ton broken. This is a serious item of cost and when the question of rock drill replacement is considered, it deserves serious study in comparing the merits of hammer and piston drills.

These considerations present themselves as being obvious:

1. The large $3\frac{1}{4}$ rock drill is a machine cheap to make and with a certain well ascertained and moderate expenditure it can be kept in a state of efficiency for a number of years. The expenditure of £5 or £6 per month renders it practically everlasting.

2. It is obvious that under the rough conditions and unskilful usage of mine work smaller drills of the same class, owing to their weaker construction, will cost somewhat more, but not very much more, to maintain.

3. With hammer drills, especially under the conditions in which they have to work on the Rand (being in the hands of natives and whites who have little or no mechanical knowledge), owing to a number of reasons they are more expensive in first cost, and owing to their lighter construction and more rapidly moving parts and the greater vibration and stresses set up by the greater evolution of energy in relation to their weight, they are bound to suffer more from wear and breakage. Grit is more easily introduced in most types, and when it is its presence does more harm.

4. When any system of introducing water to the base of hollow steel is employed, complication and risk of damage from water and rust are certain to be greater than with piston drills. Whatever the life of any type of water-feed hammer drill may prove to be, it will not approach that of a piston drill, and maintenance costs are much higher.

I recently saw some figures showing the total amount spent on spares and renewals for water-feed machines on one mine, and the amount certainly proved a serious addition to the tonnage costs broken over that period. On the other hand, I had more favourable figures quoted for other types. Mine accounts do not generally show if new drills are being bought as replacements or as renewals, and it requires often a thorough audit over a considerable period to obtain definite and reliable figures.

With regard to the employment of water-feed drills, one needs to calculate what extra rate of boring speed or breaking efficiency has been gained, and then, taking all other costs into consideration, to determine how many pence per ton in this direct extra cost one can afford to spend to gain the results obtained, and if this has been exceeded. At present the hammer drill is winning its way in development because of quicker drilling and the more rapid progress made. In stoping, its sphere lies in back stoping areas that cannot otherwise be attacked. There is, however, another aspect of the question of repairs. If any drill is continually breaking down, whatever its nominal drill speed may be, its drilling power must be greatly reduced, or there must be a corresponding increase of capital expenditure to enable spare machines to be kept in a certain proportion to those working, as even an underground mechanic cannot always be on the spot to effect instant repairs, however valuable otherwise his services may be. It is evident that the matter of repair, maintenance, and renewal of rock drills may become a most important item of cost, or even one prohibitive to any progress under the unsatisfactory conditions of labour and the average hardness of rock on the Rand.

HAMMER DRILLS. — To understand the local problem with regard to the introduction of hammer drills for stoping work, we have to consider the success they have obtained in other fields and to compare the conditions with those obtaining here. In America the introduction of hammer drills has resulted in an enormous reduction in the cost of breaking rock, amounting sometimes to halving that cost. The general conditions under which success has been gained have been:

1. Most stoping has been done in steep stopes with the air-feed type of drill, requiring no rigging-up and using solid steel. No great pains have ever been taken to avoid the dust danger, which would have added to the expense considerably.

2. The work has, on the whole, been done in ground much softer than that occurring on the Rand.

3. The great saving of time in rigging-up and taking down, and of weight in hoisting up and lowering down rises and passes, has been an important factor in cost reduction.

4. A great saving of labour as against large piston drills was obtained, since these drills are eminently one-man drills.

5. The results were obtained mainly by intelligent labour subject to discipline and under skilled supervision.

6. The hammer drill has not displaced the small $2\frac{1}{2}$ in. or $2\frac{3}{4}$ in. one-man stoping piston drill where the stopes are flatter, such as those in the North Star mine dipping 30° to 40°, and in the Lake Superior fields.

In Europe intelligent and docile labour, and strict technical control and skill in steel treatment, have enabled hammer drills successfully to displace piston drills for certain work, even in very hard ground.

All over the world where speed of advance has been a prime consideration and the ground has not been of excessive hardness, types of hammer drills like the Leyner have performed brilliantly. As the dust trouble is of such supreme importance both socially, financially, and economically on the Rand, I think a great case has been made out for their exclusive use in putting up rises and such like work here, regardless of any other considerations.

The general conditions on the Rand are so different, however, as to create a new problem, and the reasons for the many setbacks in the progress of the employment of hammer drills become apparent. We have first the question of labour cost. On the Rand the hammer drill is not a one-man drill. The air-feed type using hollow steel for putting up steep dry holes, in back-stoping and rises, is indeed sometimes worked by one native, but there is always the white supervisor. If dust is to be kept down practically two natives are required, as also in foot-walling. The average drill rate in putting up such rises is very low indeed, and their merit lies in their lightness and the ease with which they are rigged up.

Turning now to the stoping type of water-feed drills, such as the Atlas, I have never seen more than three supervised by one white man, and owing to the supposed necessity of rigging a number of bars during each shift the machines were often drilling at a much lower rate than piston drills. The hammer drill that is urgently needed on this field is the stope drill for underhand or breast stoping. This should be simple, if possible, and have no complications, due to passing air or water down the steel. It should be able, however, to drill a down hole and clear itself as well as a piston drill. It should use little air and be able to drill four or five 4-ft. or 5-ft. holes in a shift. It should be one the native can handle himself and one he will take to. Can such a drill be found? I am certain from experiments made that all the component parts of such a drill exist and that if certain conditions with regard to drill steel and its sharpening are provided, the stoping problem for narrow stopes is already solved.

PISTON VERSUS HAMMER DRILLS.—Let us now turn to piston drills in comparison with hammer drills in stoping on the Rand. So far no hammer drill has been a great success in stoping when used without arm or bar. Machines have been used without mounts for taking up foot-wall, but generally the machine required is so powerful that the ordinary native cannot or will not stand the vibration. In steep back-stopes per shift usually 8 natives were employed, 2 for each machine, one to supply steel and another to rig bars, etc. It was true that the machine could be run by one native, but the drilling rate fell off so greatly that the machine was not worth running. With drills of the Leyner type usually the same arms and bars are employed as with $3\frac{1}{4}$ in. machines, and the time spent in rigging up is about the same. Where special care and skill have been applied to sharpening and maintaining drill steel, and where plenty of spare machines or the services of an underground rock drill fitter are available, even in hard ground better drilling efficiency than that usual with piston drills is being gained. In development work a great advantage is gained in drilling dry holes. Good work is also being accomplished in stoping, but I have never heard of any miner supervising more than two or three machines. Generally speaking, much more attention has been forced on those seeking for success with this type on the necessity of paying attention to drill steel and not attempting to drill more than 12 or 18 in. with one bit. Even when this is done much efficiency is lost, and machines using solid steel and mounted on air feeds have been used with success, though dust has always been a trouble. Piston machines could not, of course, compete in this work. Most of the ore to be broken in the future will be from stopes having a dip from 5° to 30°. Except that a somewhat lighter arm and bar might be used there will be little advantage in rigging with the hammer against the piston drill. In such stopes the best style of breaking and removing rock is breast stoping. With the newer styles of chucks in use with piston drills the time taken to change jumpers is very much the same, and the manipulation and adjustment to new holes of the smaller stope drills is quickly effected.

Turning now to the question of drill speed, experiments have shown that $2\frac{3}{4}$ to $2\frac{1}{2}$ in. piston drills, when not asked to drive a drill bit of too large a diameter, easily attain a drilling speed of 4 to 6 in. per minute, which is ample for all requirements. I have shown that the large $3\frac{1}{4}$ in. piston drill is nearly always working at a very low efficiency, due to hoses being too small to start with and their being always damaged more or less, so that the machine, even if the pressure be adequate, is never properly supplied with air. I have shown that the question of the supply and quality of drill steel and its sharpening, as supplied to piston drills, has never had anything like the attention which users of hammer drills have been forced to bestow upon the subject. In stopes of moderate dip also, the most natural manner of stoping is by carrying benches down and drilling down-holes, and no type of hammer drill works so efficiently in down-holes as in up-holes. I have already expressed the opinion, based on experiment, that the rate of drilling of small piston drills could be greatly raised by using hollow steel.

In the matter of air consumption, honours are easy. The Leyner drill certainly uses less air than the ordinary large piston drill, but it uses much more than the Konomax. As far as I can judge, the cheapest way to drill rock in stope benches, as far as air consumption is concerned, is to use $2\frac{5}{8}$ or $2\frac{3}{4}$ in. Konomax drills in down-holes. The Konomax principle, though most suited for hammer drills, has not so far been embodied in a hammer stope drill. The small $2\frac{1}{2}$ or $2\frac{3}{4}$ in. piston drill can be moved to another bar almost as rapidly as any hammer drill. The inefficiency which exists in its use today is largely due to ignorance of its right use and to labour difficulties. There is room for great progress in drill rigging, and if arrangements were made always to have ready for the miner one long arm rigged between two bars much better work could be done.

Turning again to labour cost comparisons, there is no doubt that the small piston drill is the more economical in labour of the two. One white man can supervise from 4 to 6 of these machines, though, personally, I think efficiency suffers when more than 4 are given to one man, except perhaps in very flat stopes under most favourable circumstances. We must not here make the mistake of confusing labour cost per machine, which may be small, with labour cost per foot drilled. Where, for instance, two Leyners are drilling in a stope 8 or 10 effective holes per shift, even if one man looks after only two, better results are being obtained than by one man looking after 3 piston drills drilling 6 holes each. Drilling power, if it be produced in sufficient amount, pays for the increase of all other costs and must of itself automatically reduce others. If but half the work of supervision that I have seen put in some mines to make hammer drills a success were devoted along right lines to improving the work of piston drills very interesting results could be obtained.

TRAINING LABOUR.—The whole matter is largely one of lack of knowledge as to what are the right lines of advance and the lack of any attempt to give systematic training along right lines to the large number of fairly intelligent white workers who drift into the industry and pick up wrong methods of doing work. Mine captains and shift bosses are inspired by no established doctrine of what are the real lines of advance and how to strive to obtain them. Among all classes engaged underground there is an ignorance of the laws of blasting and how forces should be applied to break rock to the best advantage, of how explosives really act and how they cannot act, of the doctrine of free faces and their height as applied to the burden to be given to stoping holes, of the law of the relation of explosive necessary to break out holes to the burden given them, of the question of the right length of hole to bore under given conditions, and of what makes a hole a good and economical one or a bad and expensive one to drill. These matters I have tried to discuss in a pamphlet entitled 'Practical Mining on the Rand,' and if the maxims and laws laid down there are right the path along which progress can be made is fairly well mapped out. The worker, however, must be educated to right knowledge of them. This can be done only slowly and on a small scale at first, but if in every mine one has only two or three men working on right lines the results soon attract interest, and these men may be used to educate others. I believe the correct line of advance is the education of a certain number of stopers. Experiments should be made directed toward improving the work of piston stope drills along the line suggested; especially with a view to drilling more holes and perhaps shorter holes in narrow stopes. Experiments are needed to adapt a hammer drill for use of one native in stoping with down-holes to displace hammer boys. By using hollow steel in the way mentioned with regard to small piston drills and making the drill pump out its own cuttings, I know by experiment that this can easily be done. It only needs a few months work to find the right type of steel and drill. Experiments have already plainly shown the path of success here.

It would pay each mining group to engage an official as a sort of stoping inspector. He could find much work to do in assisting consulting engineers. He should be primarily an underground man. He should investigate on each mine the stoping problem, and should be able to teach a few miners in each mine the best methods to employ. He should also be able to carry out trials and experiments under practical conditions to find out new lines of advance. The mining industry is well pleased, as I have pointed out, to spend thousands to save but 1d. to 2d. in the cyanide department, but is content to leave far more important matters in the hands of already overworked mine officials. There is a possibility of saving a shilling a ton in stoping costs, and this sum can be saved if the best technical knowledge, underground experience, and educational capabilities are employed on the problem.

There is yet one other consideration. The cost of compensation for miner's phthisis is now 5d. per ton milled on the Rand. If the use of water-feed hammer drills will cause this disease to disappear, then this sum will more than pay for any extra expense of maintenance of this type and its steel. If we were sure that any phthisis that is being contracted were due to dust formed while drilling with piston drills, then humanitarian motives alone would require that they be replaced for all development work.

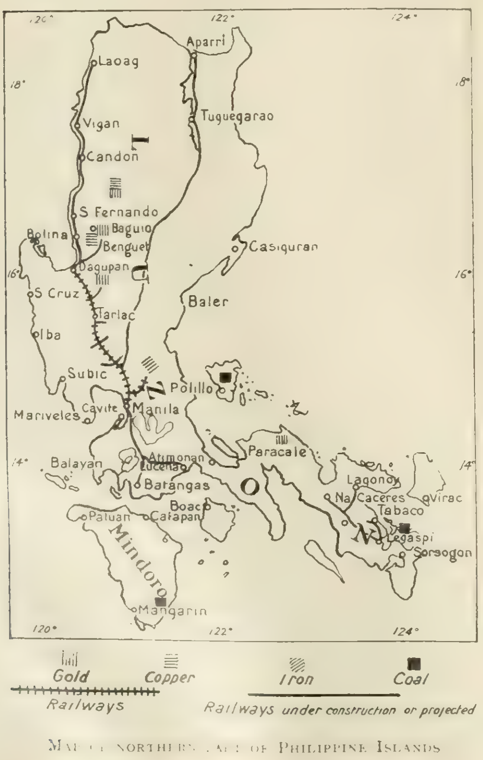
African Soda.—The Magadi natural soda deposit in British East Africa is apt to overshadow other similar deposits in the sub-continent. One that is being worked at present is at Zoutpan, 15 miles by road from Hamman's Kraal railway station and 25 miles north of Pretoria. The deposit contains beds of carbonate of soda mixed with varying quantities of sodium chloride. No doubt its exploitation for the production of soda ash, caustic soda, or washing soda would be possible and profitable, but a demand from another source has been found, involving less expenditure of capital, for the crude material has been found valuable for neutralizing the mine water on the Rand, where the increasing use of centrifugal pumps has made it desirable to adopt some such policy. The deposit was described in 1891 by Alford in his book on Transvaal geology, and an account appears in Hatch and Corstorphine's 'Geology of South Africa.' The enterprise is in the hands of business men at Johannesburg, and the company is called the S. A. Alkali Limited, having a capital of £25,000. A branch railway will have to be built from Hamman's Kraal, for the roads are bad in the wet season.

NEW PHILIPPINE GOLD DREDGES

By CHARLES JANIN.

Gold dredging is becoming increasingly important in the Philippine Islands. The situation of the fields on the sea shore and in an isolated position calls for special designing of hull, superstructure, machinery, and power plant. Full technical details of the two most modern dredges are given.

THE Mambuloa Placer Co. was organized by Joaquin Casanovas in 1914. The holdings of the company consist of 3500 acres on the northern part of Ambos Camarines in Luzon, one of the Philippine Islands. This is only a short distance from Paracale, where there are a number of dredges in operation, including the Gumaos, which was built in 1912 by the New York Engineering Co. This company has the contract for the new 8 ft. bucket dredge now being constructed for the Mambuloa company. This dredge embodies several new and interesting features. The most radical innovation is the arrangement of the motive power. The dredge is self contained and includes a steam turbo-generating plant consisting of a 300 hp. wood-burning boiler with condenser, and a General Electric Curtis 625 k.v.a. (500 kw. at 80% power factor) turbo-generator running at 3600 revolutions per minute, 440 volt, 3 phase, 60 cycle, with direct-connected exciter. Such a plant has not previously been used in gold dredging, but has been successfully operated on harbour dredges and on the big United States collier *Jupiter*. It is also the type of plant designated for the new United States battleship *California*.



MAP OF NORTHERN PART OF PHILIPPINE ISLANDS

All motors on the dredge are General Electric manufacture, and are furnished with impregnated windings, insulating them against excessive moisture or heat. The main drive motor is 150 hp. with reversible speed controller to reduce to one-third of full speed. The other motors are as follows:

	Horse power.
Main winch	20
High pressure pump	120
Low ,, ,,	75
Screen drive	40
Stacker	40

In addition to the main power plant there is an auxiliary steam engine of 20 hp. which can operate the winch and move the dredge in case of accident to the turbo-generator, during a storm or other emergency. This auxiliary engine will drive a $7\frac{1}{2}$ kw. dynamo for lighting the dredge when the main plant is shut down, and can also be used to take the place of the exciter in the generator should that get out of order.

A dredge of this type is expensive as to first cost, since the plant includes not only an electrically-driven dredge but also a separate power plant built on the dredge instead of the usual plant on shore. It is pointed out by the makers that the operating cost will be less under these conditions than it would be with a separate plant on shore, since all operations will be under the direct supervision of the dredge master and only the one operating crew will be necessary. Should a second dredge be built, as is contemplated if results are in keeping with expectations, the power plant may be moved from the dredge and suitably rearranged on shore for two dredges. The dredge has been designed with this possibility in view and the equilibrium of the hull will not be disturbed if the plant is removed. It is for this reason that a 625 k.v.a. generator, which is in excess of present requirements, is placed on the dredge, and it is evidently intended to add another boiler to the shore plant if that is afterwards arranged for, in order to obtain highest efficiency from the turbo-generator that would be necessary.

On account of the dredge being designed to work in salt water the hull will be built of wood and designed more nearly along ship lines than is usual in a gold dredge. The outside of the hull frame will be covered with sheets of tar felt material about $\frac{1}{4}$ in. thick, and this in turn covered by planks $1\frac{1}{2}$ in. thick. In addition to this the well sides and the stern of the dredge will be protected by steel plates. The hull will be ventilated by having the air which supplies the fan for the turbo-generator drawn from the hull, and suitable inlets will be arranged to admit sufficient fresh air, so that the air in the hull will be changed every ten minutes; a feature that will appeal to dredge operators in the tropics.

The hull will be 136 ft. long, 47 ft. wide, and 10 ft. deep, and built of frame having 8 by 10 in. deck beams. Forward and stern frames will have 10 by 14 in. deck and floor beams and 10 in. by 14 in. posts tenoned and fitted to them. The well planks will be 6 in. thick and will extend the entire length of hull, forming solid bulkheads. The side, bottom, and deck planking will be 4 in. thick, and the bow and stern planking 6 in. thick. The frames will be tied together with 6 by 16 in. keelsons. Alternate frames will have 4 by 8 in. diagonal braces from the well planking to the outer edge of the hull. Cross braces will be placed on all frames between the well planking and posts, will be bolted to deck and floor beams, and also to longitudinal clamps and keelsons. Alternate deck beams will extend 3 ft. beyond the edge of the hull, giving the dredge house a width of 53 ft.

The front gantry will be 40 ft. above the deck and composed of posts 16 by 16 in. The front gantry cap will be of structural steel girder 18 by 22 in., and will be fastened to gantry posts by $\frac{1}{2}$ in. plates and angles extending 4 ft. along gantry posts. The main gantry will be 30 ft. above deck and built of posts 18 by 20 in. and 18 by 20 in. cap pieces and braced with 16 by 18 in. braces. The stern gantry will be 72 ft. above deck and made of two 16 by 16 in. and two 14 by 16 in. pieces tied together with a 16 by 18 in. gantry cap, all thoroughly braced.

There will be two trusses, the upper chord of which will be 18 ft. above deck and the lower chord bolted to the floor beams in the bottom of the hull. Both of these chords will extend the entire length of the hull and be built of suitable vertical posts and of $2\frac{1}{8}$ in. square truss rods.

The dredge will work on spuds. The digging spud will be of steel 27 in. by 42 in. by 70 ft., built with 6 in. by 6 in. by $\frac{3}{4}$ in. angles, with $\frac{7}{8}$ in. cover plates and $\frac{5}{8}$ in. side plates running the full length of the spud to a cast steel spud point. The other spud will be of wood also fitted with cast steel point.

The upper tumbler will be of solid steel casting with manganese wearing plates; the tumbler shaft is 17 in. in diameter and 12 ft. long. In order to prevent side travel the tumbler is keyed to the shaft, one end butting against a shoulder and the other end being electrically welded to the shaft.

The main drive gear is double, that is, a drive wheel will be mounted on either end of the tumbler shaft. These wheels are of cast steel of 11 ft. 6 in. diameter and 10 in. face and have machine cut teeth. The main gears with intermediate shafts are mounted on one heavy steel base plate and are belt driven from the main drive motor.

The lower tumbler will be round and consist of a solid piece of manganese steel casting. The lower tumbler shaft will be hollow and of 12 in. diameter and pressed into the tumbler. The bearings are arranged with a packing ring which prevents water or grit from getting into the bearings and permits the shaft to revolve in grease under pressure. The round lower tumbler which has been successfully used in the California field for some years reduces wear on bucket bottoms and gives better results by reducing power consumption and obviating many of the strains and jars of the old form of lower tumbler.

The main dump hopper has a manganese steel bottom which may be removed, leaving the usual form of gravel bottom for the buckets to dump upon. The screen is the revolving type of 78 in. diameter, 40 ft. long, and the tires have 12 in. faces. The drive is at the lower end, and is of the single centre roller type. All screen bearings are ball and socket, self-aligning type. The upper part of the screen will have $\frac{1}{4}$ in. tapered holes, the middle part $\frac{3}{8}$ in., and the lower section $\frac{1}{2}$ in. The screen plates are arranged so they can be replaced when worn without dismantling the entire screen.

For washing purposes two pumps are used, one 12 in. high pressure direct connected to 125 hp. motor, and one 14 in. for low pressure, connected to a 75 hp. motor. This latter pump will be capable of furnishing 6000 gal. per minute against a 30 ft. head. The high-pressure pump will furnish 5000 gal. per minute. Slow speed for motors, pumps, etc., is advocated by the makers, and special attention has been given to all bearings and to machining all gear teeth to insure easy running.

The digging ladder is of the plate-girder type, 114 ft. long, and 8 ft. wide at the deepest part. It has an extension of 35 ft. in front of the dredge and can dig 50 ft. deep at an angle of 50°. The ladder is eccentrically hung and the ladder hangers are of a double suspension type, and there are also separate sets of blocks for each side. The forward suspension bars are round and $5\frac{1}{2}$ in. in diameter and the rear bars will be flat, 7 in. wide by 2 in. thick, all forged solid. An equalizing sheave is placed on top of the main gantry and a continuous rope is used through all ladder hoist blocks. By this arrangement the strain is equalized and any stretching of the rope is automatically adjusted. A somewhat similar method is also used to equalize the tailing stacker hangers. This is arranged to support the stacker at three points instead of two as is the usual custom. Hanging ropes are weaved through equalizing blocks at these three points and give equal support to each point of the stacker.

The gold in the Mambuloa placer is found in a stratum of gravel 6 ft. or 8 ft. thick underlying an overburden of 40 or 45 ft. of barren sand and clay. To handle the barren overburden a clay chute is placed directly over the washing screen extending to the stern and dividing into two branches, each branch extending 30 ft. beyond the stern of the dredge. The clay chute will be semicircular in cross-section to facilitate carrying the clay. The upper part of the chute, into which the buckets dump, will be of manganese steel and this will be hinged so that when the buckets are digging in gravel or material containing gold it can be raised and the buckets will dump directly into the hopper in the usual manner. The clay, by this arrangement, will not pass through the screen or over the gold-saving tables. The high-pressure pump will furnish water at the head of the clay sluice; an equal amount of water being discharged across the entire width of the clay sluice to facilitate the flow of material.

The buckets are specially designed for the conditions above mentioned and for easy digging; they are of 8 cu. ft. capacity and the lip, hood, and bottom are cast in one piece of manganese steel. This is the first time that an entire one-piece cast steel bucket has been made for a modern gold dredge, but the makers contend that it will prove a success in this field, although it would not be feasible where the ground was hard to dig. Having no rivets on the inside of the bucket it is also believed that the clearing of the bucket when digging clay will be facilitated. There are 96 buckets on the line. The buckets are made by the Edgar Allen American Manganese Co. following the design of the New York Engineering Co.

The gold-saving tables are of the semi-double decked type, that is, the upper five tables on each side will be double decked and will extend out over the side of the hull to the stern. The inside tables will empty into a side sluice which will run aft to the stern of the dredge there emptying into the tail sluice. The area of the gold-saving tables will approximate 4000 sq. ft. The main sluices will be fitted with iron-shod wooden riffles and the side sluices with angle iron riffles.

A belt conveyor will carry the oversize from the screen to 95 ft. beyond the stern of the dredge and can stack to a height of 35 ft. The stacker frame is of lattice girder type 110 by 5 ft. Troughing idlers mounted on self-aligning bearings are placed 4 feet apart, and the conveyor belt is 38 in. wide. It is made of 8-ply 32 oz. duck, with $\frac{1}{8}$ in. rubber cover. The dredge is fitted with a travelling crane of 10 ton capacity, separate washing down pumps, etc., and included in the outfit are three fuel scows 40 by 15 by 5 ft. and a 40 ft. petrol launch for carrying passengers and hauling the scows.

The total cost of the outfit with dredge ready for operation on the property is approximately $220,000.

A table giving comparisons between the mechanical details of the Gumaos and Mambuloa dredges accompanies this article, and in connection with the latter dredge it is interesting to note the following abstract from the *Bulletin* issued by the Bureau of Science in the Philippines for 1914:

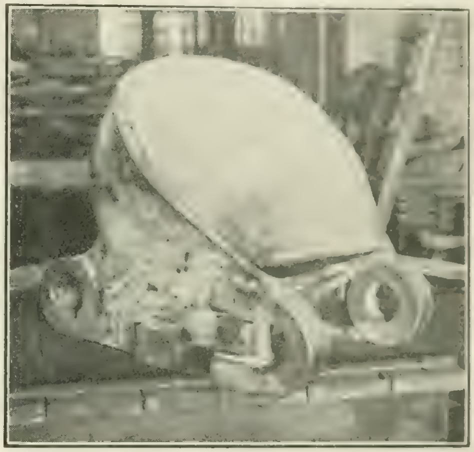
"The Gumaos dredge handled 814,500 cu. yd. while operating 5731 hours in 1913 and produced $193,176. The operating expenses covering all repairs and overhead charges were $59,684. The total amount of dividends distributed during the year was $125,000.

COMPARISON OF GUMAOS AND MAMBULOA DREDGES.

	Gumaos	Mambuloa
Buckets		
Number	85	96
Capacity, cu. ft.	6	8
Pitch, in.	30	33
Pins, diam. in.	$4\frac{1}{2}$	5
Type	2 pieces	1 piece
Material	Manganese insert	All manganese
Thickness of bush	3 in., $1\frac{3}{4}$ by 12 in., with 7 in. wear	$\frac{7}{8}$ in., 2 by 12 in., 12 in. wear
Digging ladder		
Type	lattice girder	lattice girder
Size, ft.	87 by 7	114 by 8
Suspension	single	double
Chord angle, in.	4 by 6 by $\frac{1}{2}$	4 by 6 by $\frac{5}{8}$
Extension in front, ft.	27	35
Upper tumbler		
Shaft size, in.	14	17
Shaft bearing, in.	12 by 17	14 by 19
Lower tumbler		
Shaft size, in.	10	12
Shaft bearing, in.	8 by 10	10 by 12
Type	2 part hex.	1 piece round manganese
Screen		
Type	revolving	revolving
Surface length, ft.	24	32
Overall length, ft.	32	40
Diameter, ft.	5	$6\frac{1}{2}$
Slope, in per ft.	$1\frac{3}{4}$	$1\frac{3}{4}$
Save all		
Bars	$\frac{3}{4}$ in. by 3 ft.	$1\frac{1}{4}$ in. by 6 ft
Tables		
Area sq. ft.	3600	4000
Riffles, in.	$1\frac{1}{2}$	$1\frac{1}{2}$
Slope, in. per ft.	$1\frac{1}{4}$	$1\frac{1}{4}$
Stacker		
Length, ft.	85	110
Belt width, in.	38	38
Truss depth, ft.	5	5
Drums, diam. in.	41	41
Chord size of ls., in.	$\frac{3}{8}$ by 3 by 4	$\frac{1}{2}$ by 3 by 4
Spuds		
Overall length, ft.	55	70
Steel spuds. No.	1	1
Bow gantry		
Cap	steel girder	steel girder
Uprights, size, in.	12 by 16	18 by 22 16 by 18
No.	4	4
Stern gantry		
Cap, in.	14 by 18	16 by 18
Uprights, size, in.	12 by 14	14 by 16
No.	4	—
Pumps		
High pressure, in.	8	12
Low pressure, in.	12	14
Gal. per min.	6800	11,000
Hull		
Material	wood	wood
Water line length, ft.	120	$135\frac{1}{2}$
,, ,, width ,,	40	47
Depth.	$8\frac{1}{2}$	10
Main truss height, ft.	21	19
Overhang, ft.	—	3
Well length, ft.	62	76
Well width, in.	69	74
Main Winch		
No. of drums	9	9
Ladder rollers		
Diameter, in.	14	16
Length, in	13	36
Motors		
Main drive, screen, conveyor, kw.	150	150
Main winch, kw.,	20	20
High-pressure pump, kw.	55	125
Low-pressure pump, kw.	50	75
Service pump. kw	5	40
Wire ropes		
Ladder hoist, diam. in.	1	$1\frac{1}{2}$
Spud ,, ,, ,,	$\frac{3}{4}$	$\frac{7}{8}$
Stacker ,, ,, ,,	$\frac{5}{8}$	$\frac{3}{4}$
Swing lines ,, ,,	$\frac{7}{8}$	1

"The alluvium consists of about one metre of soil at the surface, then from 3 to 4 metres of yellow clay and from 5 to 9 metres of black sticky clay, below which is the pay gravel which varies in thickness from 0·3 to 1·5 metres. The dredge has justified expectations as to its efficiency and durability. The buckets, which were the first cast steel buckets to be used in the Philippines, are satisfactory in every respect and show very little wear. It is claimed that about 85% of the gold in the ground is saved on the tables. The largest portion of this gold is caught in the first metre of the first four tables."

The Gumaos was originally built with a



ONE PIECE MANGANESE STEEL BUCKET MADE FOR THE MAMBULOA DREDGE.

line of 85 buckets and designed to dig 38 ft. below water. The ladder was afterwards lengthened 24 ft. and 20 additional buckets furnished so that the dredge could handle deeper ground. At the same time the front ladder hangers was changed to the double type, that is, having two bars extending fore and aft from the main lower block. The ladder suspension was double from the first, but the hangers were arranged single in order to allow for the ladder extensions, as originally contemplated.

[In addition to the dredges described above it may be mentioned that there is a new Yuba boat at Malaguite, while Umari Gold Ltd. operates a new steel-hull, 7 cu. ft., dredge of Australian make, in Eastern Luzon, north of Paracale. Paracale Dredges Ltd., another Australian company, operates several older boats. The credit for developing the field must be given to the Australians, and the local capitalists. There are promising areas still to be exploited.—EDITOR.]

TAXATION OF MINES IN AUSTRALIA

By H. R. SLEEMAN.

In the effort to break up large estates the Federal Government of Australia has enacted legislation which, if sustained by the courts, will impose unequal and possibly heavy burdens on mines. Incidentally it threatens, unnecessarily, the interests of non-resident shareholders and calls for vigorous protest.

IN 1910 the Federal Government of Australia passed a land tax assessment bill. The bill was supposedly designed primarily for the object of breaking up many of the big pastoral estates and so supplying additional lands for closer settlement, mainly for agriculture. As is common, the act was found to have many issues and effects not foreseen by its framers. It, however, does not concern us to follow these beyond the issue raised as to mines. So far as I know the issue was raised by the Federal taxation authorities with regard to mining freeholds late in 1912. At that time returns were demanded from mines on freeholds giving the unimproved value of the land, the said value to include the mineral contents.

The first attitude of the companies concerned was to decline to admit that the land tax applied to mineral contents at all. Eventually, after much negotiation and discussion the issue was narrowed down to the interpretation of the term "unimproved value," when applied to mineral contents. For the companies it was contended that the unimproved value of the land, including mineral contents, at any date is the amount for which the land could be expected to be sold in the open market and with both buyer and seller reasonably willing to deal, supposing that it remained in a state of nature, that is, that no work whatsoever had been done on it.

The contention is that, inasmuch as all further value put upon the land, through the proving of the existence of such value by prospecting, development, or other work, is put there solely by that work and but for that work the increased value would not have come into existence; the said further value is part of the improvements. In other words that the proof or knowledge of mineral contents exposed by improvements is acquired solely by the improvements and therefore that the additional value created by the said proof or knowledge is also created by the improvements. The logic of this seems clear. Of course, the mineral contents are not created by the improvements. The land, however, in its untouched state has a certain speculative value. All additional value created by the facts brought to light by improvements is certainly created by the improvements. If it is created by the improvements it is illogical to contend that it is a part of the unimproved value. In fact, it might be said that the added value is part of the improvements. It certainly is an improvement, using the word in its more general sense.

To this contention the Government reply is that the mineral contents, having always been there and having been only discovered or exposed by the improvements, the value of the mineral contents so exposed has also been there. This is illogical. The mineral contents being there is a totally different thing from the value being there. While the existence of the mineral contents was unknown they had no value. This fact at once shows that the existence of the mineral contents and their value are totally different matters, and do not necessarily go together.

The value is dependent on the two factors, the existence of the mineral contents and the knowledge of such existence. Inasmuch as the knowledge gives value to that which before had no value, the knowledge creates the value. One might as well maintain that a new invention, which applied natural substances and forces, can have no value because the natural substances and forces, which the invention utilized, existed previously to that knowledge of the substances and forces which enabled them to be utilized. Thus steam and its potential ability to perform work already existed. Therefore the invention of the steam engine should have, on the argument of the Australian Government, no value in itself, the value having already previously existed in the substances and forces which the invention utilized.

The instance quoted exemplifies the fact that knowledge can and does create value. How then can value created by knowledge be ranked as part of the unimproved natural material?

The act describes "improved value" as follows: "the capital sum which the fee simple of the land might be expected to realize, if offered for sale on such reasonable terms and conditions as a bona-fide seller would require, assuming that the improvements (if any) thereon or appertaining thereto and made or acquired by the owner or his predecessor in title had not been made." This makes the Government contention paradoxical. We are to assume that we have a certain knowledge, and yet we are to assume that the only possible means of obtaining that knowledge does not exist, that is that we have not the said knowledge.

The act proceeds to define the "value of improvements" as "the added value which improvements give to the land at the date of valuation, irrespective of the cost of the improvements, provided that the added value shall in no case exceed the amount that would reasonably be involved in bringing the unimproved value of the land to its improved value as at the date of assessment." This, of course, plainly states that no increase in value, due to additional knowledge created by improvements, is to be treated as part of the improvements, but as an addition to the unimproved value. In fact, it is inconsistent with the preceding definition of "unimproved value."

In December 1914, the Federal Government amended the land tax assessment act to include leaseholds, including mineral leases. This made the matter under discussion one of vital interest to all engaged in Australian mining. The matter being then taken up by the different companies in Western Australia, as a result of the negotiations with the taxation authorities, the following formula was adopted as a basis for returns:

FORMULA.

Estimated tonnage and gold contents of ore reserves as at June 30, 1914.

Take 85% of same, being estimated extractable value.

Deduct—

1. Requirements to realize the above value (assuming that although the fact was known that certain bodies of ore existed at certain depths, no improvements had been made); full cost of shaft or shafts (ventilation must be taken into account) at points nearest to orebodies.
2. Cost of development work (not from shafts in existence at present, but footage that would be required from new shafts) as per clause 2.
3. Cost of new plant and machinery of suitable capacity to treat ore reserves.
4. Cost of extraction and treatment.
5. Interest on capital required to carry out development, and the erection of plant and machinery.

   Take 4½% of the remainder and (after deducting lease rent) multiply it by the number of unexpired years of the lease; deduct from the result the exemption of £5000 and the remainder is the taxable value.

Presumably the formula applies to all mines, and not only 'gold,' which alone is mentioned. It will be observed if the formula be applied to a few test cases that only a rich mine with large ore reserves would be taxable. I understand it is the intention of most of the mines to give returns simply as "no taxable value," as the formula applied to such mines would show no taxable value.

This is a very different matter from the original contention of the authorities that the return should show simply the reasonable buying and selling value of the mine at the date of return less the cost of the improvements, in fact the price at which the owner was prepared to sell.

While the above formula has been adopted for temporary purposes a case has been cited before the High Court of Australia in Sydney. The court will decide, if the case comes before it, on the principle as to the interpretation of "unimproved value" as applied to mineral contents of land. It is, however, not certain that the defendants will enter an appearance. If the court decides against the Government contention presumably the above formula (or any other) will become unnecessary.

In the meantime, it may be taken as certain that legal opinion on the matter will be divided. The doubtful points include the question as to whether the act applies to mining leases of the Crown granted before the date of the act. There is a question also as to whether the taxing of these Crown leases by the Federal Parliament is constitutional. These lands belong to the several States and it is doubtful as to whether the Federal tax does not infringe the rights of the States in their sole control of such lands. It is easy to establish a case showing that such taxation may seriously affect the value of such land to the State and hamper the State in utilizing them to what the State considers its best interests and may, in fact, generally interfere with the State Government's functions in its control and management of such lands. It seems possible, therefore, that the issues raised by this tax may yet find their way to the Privy Council for settlement.

In fact there is a report to the effect that certain mining interests are preparing to fight a test case on this issue of constitutionality. In dealing with the actual application of the tax, if the Government contention is upheld, certain facts and effects on mining are plain.

1. It tends to place a penalty on the developing of mines well ahead of treatment requirements. The same mine with, say, half a million tons developed, would be valued at very much more than with, say, a quarter of a million tons. Indeed, in the former case it might be assessed at a high figure and in the latter case at nothing. A premium, therefore, is placed on the neglect to develop any mine beyond the point at which it would come within reach of the tax. A more unsuitable basis of taxation can hardly be conceived. It would certainly appear that this aspect of the matter cannot have been appreciated by the framers of the act. It seems unthinkable that they should designedly frame the act in such a way as to provoke action which is directly destructive to the productivity of the tax and destructive to it indirectly through the shrinkage in operations so caused. The objections to this phase of the matter cannot be overstated.

2. Valuation based on the formula has obviously but little relationship to valuation based on supposed selling value of the land. Mines which would pay under the formula the same amount of tax might have widely different selling values. For instance, a mine which was mostly exhausted, but which had its development work completed might have the same value in ore reserves as a young mine which had prospects beyond its ore reserves of many years supply of ore. The latter might, as regards the unimproved value of the mine, greatly exceed the selling value of the former, but would pay equally under the formula. Again, two mines making the same profits, and with the same prospects as to life, might pay very different amounts of tax.

3. In the above it is assumed that the periods of unexpired leases have in the different cases been identical. In regard to the period of unexpired leases, however, another glaring anomaly exists. The mining leases are for 21 years, and it is universally understood that on the expiration of the first term the lease is renewed for a similar term if required. In one or more of the States, certainly West Australia, this renewal is a statutory right. It is obvious, therefore, that the period of unexpired lease has no relationship to the future life, that is, with the value, of the mine and that to make the valuation of a mine depend on the length of such period is illogical. This would become reasonable only on the basis that the exhausting of a mine started very shortly after the starting of a lease period, that is, in 21 years, and finished about the end of the lease period.

Great inconsistencies are actually created. There are cases where old mines which have been working for practically the whole of their lease period and are understood to have only a few years of life remaining. These mines, however, have recently had to take on fresh periods of lease, with the result that mines nearly exhausted may have a long period of unexpired lease. In contradistinction to this are leases which have perhaps been held for a period of little less than the 21 years, while the properties for one cause and another have been worked very little. These have practically the whole of the mineral contents yet to be exhausted, and therefore have a long prospective life. Because, however, there remains only a small portion of the 21 years lease remaining, the valuation is made proportionately small. Toward the end of the lease the valuation would diminish to nothing and then jump instantaneously to perhaps a large amount on the granting of a new lease.

4. The tax is collectable either on a personal basis or as from each particular mine, or mining company. Thus having arrived by the formula or otherwise at a valuation of a mine, and supposing that a taxable value is indicated, the mine is rated accordingly. If, however, any of the shareholders possess personally a bigger total taxable value in unimproved land (including mineral) value than does the mine, such shareholder must pay in regard to his interest (shares) in the mine, the difference between the rate of tax on his total taxable interest and the rate of tax on the mine.

This is perhaps best illustrated by a suppositititious case. A man *A* has 4000 shares in the mine *X* and 2000 shares in the mine *Y*. He has also land and other mining interests, the total unimproved value of which is assessed at £25,000. The mine *X*, we will suppose, has 200,000 shares, and the unimproved value is fixed at £50,000; the mine *Y* 300,000 shares and the unimproved value £15,000. With regard to *X* the rate of tax payable by the mine is higher than that payable by him. He therefore pays direct no tax in respect of his shares in *X*. In the mine *Y* the rate of tax is less than the rate on his personal interest in unimproved values. He has therefore to pay the difference.

The rate of X is 3·4d. per £. The rate on Y is 1·53d. per £. *A's* interest in the unimproved value of X is £1000, in that of Y £100. His total interest in unimproved value is therefore £26,100. The rate on A, therefore, is about 2·125d. in the £. With regard to X, he is therefore not taxable. With regard to Y he has to pay about 0·595d. in the £. He pays, therefore, at the rate of 2·125d. on £20,000, and of 0·595d. on £100. Besides which he has indirectly paid 3·4d. on £1000 (interest in X) and 1·53d. on £100 (interest in Y).

The above shows that the Government taxes either the lease (mine) or the person according to which would yield the larger tax. If A were an absentee his rate would be 3·125d. on £25,000 and 1·595d. on £100. A mining company ranks in all cases as a resident.

The following is an example of the application of the formula :—

Estimated value of minerals :			
No. 2 level, No. 4 level to No. 20 level — specify tonnages — 621,000 tons at 33s. 7d. per ton			£1,042,762
(*Plus* prospective value of undeveloped ore ?)			....
			£1,042,762
EXTRACTABLE VALUE taken at 85%			£886,348
Total cost* (estimated) of shaft sinking and development work required to reach ore, say :			
Shaft sinking	£59,840		
Development	62,100		
		£121,940	
Total cost of plant and machinery suitable to effect treatment of 621,000 tons		140,000	
Cost of treatment (621,000 tons at 18s. per ton)		558,900	
			820,840
			65,508
Interest on capital, say £350,000 at 5% for 2 years (or for such period as may be required to carry out shaft sinking and development)			35,000
			30,508
Take 4½% of £30,508 as the annual economic rental			1,373
Deducting lease rent, say			50
			1,323
Multiply by unexpired term of lease (say, 12 years) = 9·322 in present value			12,333
Exemption			5,000
			£7,333

* Cost of shaft sinking should include all working costs, supervision, administration, insurance, etc.

In the above case the company would be liable to taxation on £7333 and an absentee shareholder on £12,333 proportionate to his interest in the company, less the proportionate part of tax paid by the company on his behalf.

An absentee's interest may carry a bigger or smaller amount of tax according to whether calculated on the basis of the tax on the mine or on the personal basis. The personal tax would or would not exceed his proportion of the tax on the mine according to whether his interest were sufficiently large or not. In this case his interest would have to be over £7333 before he would become directly taxable, that is, he would have to own over $\frac{7}{12}$ of the total shares. This supposes that he has no other interests in Australia taxable under the act.

The schedules in the land tax act for calculating the amount of the tax to be paid are as follows :

(1) WHEN THE OWNER IS NOT AN ABSENTEE.

For so much of the taxable value as does not exceed £75,000 the rate of tax per pound sterling shall be 1d. and $\frac{1}{18750}$d. where the taxable value is £1 and so increase uniformly with each increase of £1 of the taxable value by $\frac{1}{18750}$d. For £1 of taxable value in excess of £75,000 the rate of tax shall be 9d. The rate of tax for so much of the taxable value as does not exceed £75,000 may be calculated from the following formula :

R = rate of tax in pence per pound sterling.
V = taxable value in pounds sterling.

$$R = \left(1 + \frac{V}{18{,}750}\right) \text{ pence.}$$

The taxable value starts at £5000. There is exemption to that amount.

(2) WHEN THE OWNER IS AN ABSENTEE.

The tax up to £5000 is 1d. in the £. From £5000 to £80,000 the rate per £ is 2d. plus $\frac{1}{18750}$d. for every £ in excess of £5000. For every £ in excess of £80,000 the rate of tax is 10d. The rate of tax for so much of the taxable value as exceeds £5000 but does not exceed £80,000 may be calculated from the following formula :

R = rate of tax in pence per pound.
E = excess of taxable value over £5000.

$$R = \left(2 + \frac{E}{18{,}750}\right) \text{ pence.}$$

In this case there is no exemption.

If, therefore, an absentee held a total in unimproved values (including shares in mines which were taxable) much in excess of £80,000 he would pay a high rate of tax. If he held £80,000 in such values the rate would be 6d. in the £. In the case of an owner who is not an absentee, who owned a total unimproved value of £80,000, the rate would be 5d. in the £ payable on £75,000.

For purposes of this tax the total in unimproved value of a man's holdings in land, freehold or leasehold, whether held in person, in partnership, or in company shares, are added together and the tax levied on him accordingly. As the rate of tax becomes very high when the unimproved value held by a person is large, the tax is calculated to discourage all such persons in Australia from putting money into mining enterprises. This applies to the principle of the tax. As long as the given formula is adhered to as the basis it would seem that so few mines would be taxable that such landholders would not run great risks of being unduly mulcted by the tax if they invested in mines. Against this is the fact that the details may not, and probably will not, be understood by the bulk of laymen, and that it will be regarded as a penalizing levy on such persons and the effect be to prevent such persons from investing.

There are still further inconsistencies in the incidence of the tax. Thus persons at whom the tax is aimed might pay no tax. Such might possess large interests but in mines which are not taxable. Again, persons holding much less valuable interests might be taxed because their interests happen to be in a mine or mines which are taxable. Again, the amount of tax collected will depend only partly upon the number and the richness of taxable mines in the country. It will depend also upon who happens to be the shareholders in the different mines and upon other factors.

Probably few absentee shareholders in Australian mines are large landholders in Australia. Probably also there are few absentee shareholders whose total interest in the unimproved value of mines in Australia cause them to be taxed at the top rates. The tendency would certainly be for any such to sell their shares in taxable mines to others not having such interests and to whom consequently the shares would be more valuable. Thus the identical shares which pay one rate of tax if in one person's possession pay a different rate of tax when in another person's possession. That, however, is the root principle of this land tax as applied to surface values of land, which was the original intention. The above tendency would also, by restricting the number of purchasers, tend to lessen demand and consequently to lower the prices of shares. Among the results may be the holding of shares by nominees.

Undoubtedly the effect must be a tendency to restrict those already having large interests in Australian lands and mines from further investment. Whatever may be the point of view of the Australian Government as to the desirability of this tendency as applied to residents, it is inconceivable that it should wish to restrict such investments in the case of absentees. It can have no possible effect on Australian interests or policy as to whether a certain quantity of mining shares are held by one absentee or by a hundred absentees.

It is obvious that, apart from the formula for valuation, the principle of this tax as applied to mines is wrong. It is inequitable in its incidence, it is impossible to secure for its purposes reasonably accurate assessments (especially in mining of metals other than gold), is costly in collection, and it is of a nature calculated to discourage enterprise.

The whole of the facts in connection with mining indicate a tax on profits as being the one sound and equitable method of securing State revenue from mines. This may be suitably supplemented by taxes of a nature designed to discourage the holding of valuable ore deposits idle. These facts appear to be so well recognized today that it seems a matter for surprise that the Australian Government has imposed a tax on mines on the lines described, which are entirely opposed to these facts. The Australian States have themselves heretofore followed such principles, except as regards customs duties on mining machinery. These, again, have been imposed not as taxes on the mines but as a means of encouraging local manufacture.

While, however, the tax may have an ugly look and is based on entirely wrong principles in respect to its application to mines, it appears that its actual direct taxing effect will be small and that prospective shareholders need not allow it to unduly influence them. It would appear indeed on the basis of the formula that only a small total revenue will be obtained from the mines under this tax. The amount promises to be quite disproportionate to the labour involved in its collection and to the injury, in the way of destruction of confidence, it may do.

It is largely for the purpose of minimizing any needless destruction of confidence that this explanation is written. An additional reason is the hope that public interest may be aroused and that such interest may take a practical form in the way of representations being made to the Government. If such were made from the right quarters and on behalf of the large absentee interests in Australian mines there would seem little doubt that some modification would be effected.

DISCUSSION

Surveying Drill-Holes.

The Editor:

Sir—Permit me to discuss briefly the subject of surveying diamond drill-holes raised by Mr. E. C. Bloomfield's letter in the May issue.

The action of capillarity of a hydrofluoric acid solution in a glass tube has long been recognized by the exploring engineer. For the last few years we have adopted a standard tube for all our inclination tests. By experiment we have obtained data for correction charts to use with these tubes. Trusting that it may be useful, we enclose a copy of one of these charts for use with the Sargent company's tubes, 1 in. outside diameter, 4·4 in. long. With the use of the chart the true inclination of the hole can be obtained for the point at which the hydrofluoric acid test is made. Between any two consecutive points at which readings are taken, the hole is assumed to follow the path of a simple curve or the arc of a true circle.

Assuming as an instance, a 70° hole drilled to a depth of 300 ft., having the following corrected angle readings: 70° at 100 ft., 68° at 200 ft., and 65° at 300 ft. To plat this hole, we would lay off the first 100 ft. as a straight line at an angle of 70° to the horizontal. The difference between readings at 100 ft. and 200 ft. is 2°. This 2° is assumed to be the exterior angle between the tangents of a simple curve joining these two points. The continuation of the first line platted is used as a tangent of a simple curve beginning at the 100-ft. point. The angle between this tangent and the chord of the curve is 1°. In practice the length of the chord is assumed as having the same length as the corresponding arc of the curve. This chord produced forms a tangent for the next succeeding curve, which is platted in a similar manner. In this instance the difference between readings at 200 ft. and 300 ft. is 3°; hence the deflection angle from the tangent for establishing the position of the chord between 200 ft. and 300 ft. is $1\frac{1}{2}$°. The various points located in this manner are then connected by an even curve.

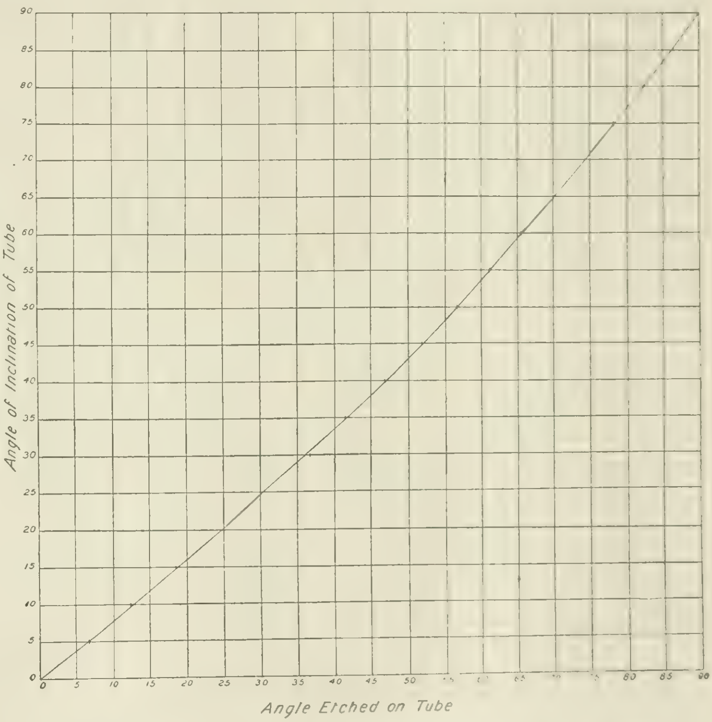


DIAGRAM OF CORRECTION FOR ERROR DUE TO CAPILLARITY IN TESTING DRILL-HOLES.
To be used for Sargent tubes, 1 in. outside diameter and 4·4 in. long.

For a greater depth of hole a succession of similar curves is platted.

E. J. LONGYEAR,
President E. J. Longyear Co.

Minneapolis, June 21.

The Editor:

Sir—In your footnote to my letter in the issue of May on the 'Dip of Drill-Holes,' you misinterpreted my meaning in connection with the filling of the test-tube with another liquid. Perhaps I did not make it sufficiently clear, but I said nothing about filling the tube *above* the hydrofluoric acid. What I suggested was the use of a liquid which would not attack the glass during the process of reading the angle after the tube had been taken from the hole and the hydroflouric acid emptied out of it.

E. C. BLOOMFIELD.

Zyrianovsk, Siberia, June 22.

[We are glad Mr. Bloomfield has put us right in this matter. Our error arose from a misinterpretation of his use of the word 'fill.' We understood him to mean that by 'filling' the tube to the top the effect of capillarity would be removed, and the true level of the liquid ascertained.—EDITOR].

Prospecting in the Eastern Tropics.

The Editor:

Sir—In reading Mr. Gilmour Brown's interesting article 'Prospecting in the Eastern Tropics,' in the July number of the Magazine, I notice that the expression "rattan lagging poles" in the explanatory note underneath the second illustration is incorrect. Rattan, or 'rotan' as it is spelt in the Malay language, is a vine; it never grows to a diameter of more than an inch or so, and in the green state is much more pliable than the rattan canes of which one sees so much now. It is universally used by the Malays in place of rope and hawser. This is borne out in the text of the article in which, on page 32, the lagging is described as of "specially tough timber," and as of "softwood" for deeper work, while "the sets were . . . hung by rattans from each other." The last quotation shows the use of the rattan.

G. S. PATERSON.

Hartley, Northumberland, July 30.

[We are indebted to Mr. Paterson for setting us right in this matter, and for the interesting additional information he has given.—EDITOR].

The Camel Prospector.

The Editor:

Sir—We have all heard of that famous burro, the alleged discoverer of the Bunker-Hill mine, in the Cœur d'Alene district, Idaho. Perhaps an instance in which a camel played a similar rôle may be of interest.

At Coolgardie in the early part of 1895, I, together with many others, contracted enteric fever and had to leave for Perth. On the afternoon prior to my departure, two prospectors, Northmore and Doolette, brought to our office in Bayley street a camel loaded with quartz, samples of an important discovery in a new district, which they christened Niagara. In the hospital at Perth, in a cot next to mine, was a sufferer with enteric fever from the mines. His name was Cameron and his case was serious. One day, moved by some constraining impulse, I recounted the recent great find, mentioning the names of the prospectors and the presence of the camel. The effect on the patient was magical, and from that moment he began 'to sit up and take notice.' It seemed the camel was his and these his partners. Fanned with this incentive the vital spark revived and the patient recovered.

It appeared that the camel was a contribution to a former expedition, which was futile, and Cameron was then taken ill with fever, and the subsequent successful expedition was without his knowledge, the camel being commandeered without sanction. Apparently no suitable settlement was forthcoming and the case came into court. The judge ruled that the camel, being the property of the plaintiff although used without his knowledge or consent, constituted his share in the expedition, and he was thereby entitled to one-third of all the discoveries made. The third interest of the sale of the properties in the Niagara district netted the fortunate owner of the camel a substantial sum, on which he soon married and no doubt "lived happily ever after."

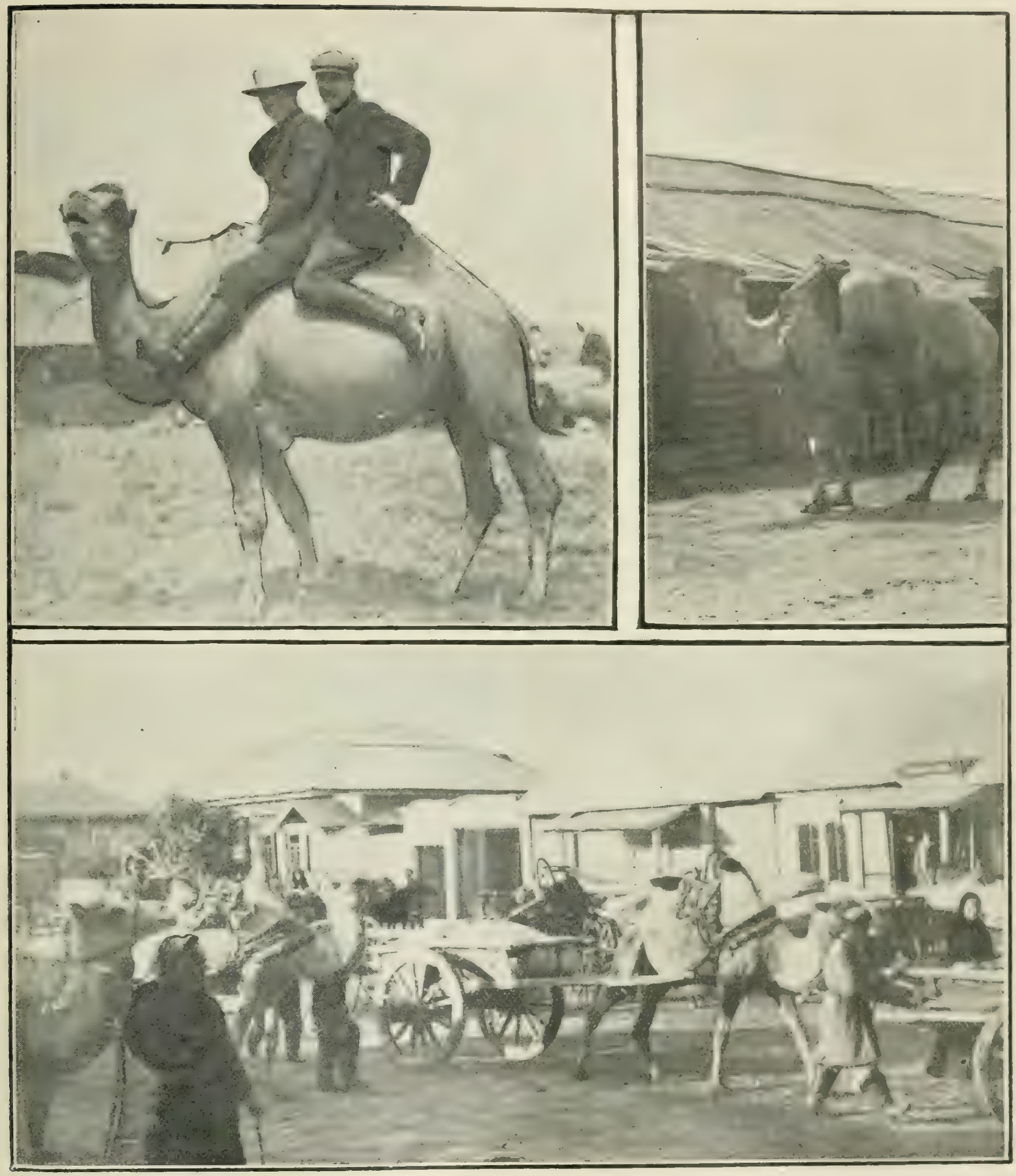
Thus are the cases of the camel and the burro analogous, although there is no record of such active prospecting work on the part of the camel as of the burro, whose vigorous hind hoofs are alleged to have laid bare the riches beneath the outcrop.

The illustrations do not depict either the identical camel of romance or the intrepid prospectors. Coolgardie's camels were imported from Beluchistan. These pictures portray relatives a thousand miles or so north of Cabul. The camel is one of the most adaptable of animals. In Australia it was introduced to meet strenuous conditions, a semi-arid country of intense heat and bare of feed to all but a camel. On the Siberian steppes the conditions are reversed. In summer there is plenty of green feed. In winter, when the fierce snow-storms called 'boraus' sweep over the frozen steppe, the camel of all animals is alone capable of facing its fury. This picturesque presence is introduced, therefore, if not to point a moral, to adorn our tale.

H. E. WEST.

London, December 28.

[Supplementing Mr. West's account, we may note that the use of camels for transport in northern Asia is graphically described by H. G. Perry-Ayscough in his diary of travels, published in 'With the Russians in Mongolia.'



THE CAMEL AS A BEAST OF BURDEN IN SIBERIA.

Both ponies and camels were used when crossing the mountains amid snowstorms and biting winds. He tells of one stage where two camels were employed for hauling the carriage through thick snow. The carriage was continually getting off the track and sticking in snow-drifts three or four feet deep. The Mongol drivers were helpless, and the camels themselves had as little initiative. The traveller had to assume control, and his language, a medley of broken Chinese, Mongol, Russian, and forcible English, was effective in making the Mongols and the camels move. Eventually the stage was completed by a mixed team of camels and ponies. Accounts have also been published by the engineers of the Atbasar describing the value of camels in the Khirgese steppes.—EDITOR].

SPECIAL CORRESPONDENCE

JOHANNESBURG.

EARTH TREMORS.—Reference has already been made in these columns to the fact that the earth tremors on the Rand have increased in number and intensity, but the increase has been so marked recently that the Government has appointed a Commission to investigate the subject, the first sitting being held on June 29.

It was not until five years ago that these earth tremors made their appearance, and as they exactly resembled slight earthquakes they were at first put down to that cause. As time went on they became more frequent, and it soon became apparent that they were local, the opinion becoming general that the tremors were due to mining subsidences rather than earthquakes despite their close resemblance to the latter.

Mr. H. E. Wood, the chief assistant at the Union Astronomical Observatory at Johannesburg, has during the last five years given considerable attention to the subject, and was the first witness called before the Commission. He stated that during the years ended June 30, 1911 to 1915, the number of tremors recorded were 19, 36, 113, 186, and 466 respectively. These records were obtained at the Johannesburg Observatory from a self-recording seismograph. Only one out of every three of the tremors were noticeable by the inhabitants. The most severe local tremor hitherto experienced in Johannesburg was one-seventh the intensity of an ordinary earthquake. From the behaviour of the seismograph when recording a tremor, Mr. Wood considered their origin local, and at a comparatively shallow depth from the surface, while the fact that they were confined to a limited region with Johannesburg as the centre, and not extending even as far as Germiston and Krugersdorp, caused him to arrive at the conclusion that they were the result of mining operations. They were, he considered, the natural result of the tendency of large subterranean cavities caused by mining to become closed under the influence of gravitation, and the greater the horizontal dimensions of these cavities as compared with their vertical dimensions the greater the tendency was marked. Mr. Wood made one assuring statement for the inhabitants of Johannesburg, to the effect that these tremors were not likely to damage property in the town. Mr. Wood, in dealing with the question of their prevention, said that if ample pillars in suitable positions were left there would be no local tremors, but if the pillars flaked and became reduced in size these earth tremors would occur. He further stated that he did not consider the leaving of pillars in a mine-working to be the correct way of supporting the hanging wall, but stated that building loose rock pillars followed by sand filling was a far better method of supporting underground workings.

Most engineers with practical experience of deep mining will probably agree with the opinions expressed on theoretical grounds about the inadequacy of pillars for protection of the deep underground workings on the Rand. In fact, at the depths at which mining is now carried on in the particular region where these tremors originate, the leaving of pillars seems more prejudicial to safety than otherwise. It must not be forgotten that the hanging wall of the Witwatersrand mines consists almost entirely of quartzite, and unlike slate or shale shows little tendency to yield or bend under the influence of 'top weights,' but rather to snap suddenly. Moreover, at depths like 4000 ft., which are fast being attained at some of the deep mines of the Central Rand, the home of these earth tremors, it is almost impossible to leave adequate pillars if the big mills necessary are to be kept fully employed. The best method of working likely to be at no distant period evolved would seem to be associated with the total extraction of the lode followed closely by sand-filling operations. Whether the advancing or retreating method of working is adopted will not matter, because once sand-filling has taken the weight, it becomes so solidified that driving of levels through it can be conducted with impunity. This method of mining will also have the advantage of materially reducing the cost of mining on the Rand, which of itself is becoming increasingly necessary owing to the almost general decrease of assay-values of the Main Reef series, as greater depths are attained.

FAR EAST RAND.—It is to be hoped that the outcome of Dr. E. T. Mellor's paper, read before the Geological Society here on the 'East Rand,' will be the settling for ever of the question of the relation of the Van Ryn reef to the Main Reef series. Dr. Mellor, in his capacity as a member of the Union Geological Survey, has been for some time busily engaged in making a geological survey of the Witwatersrand goldfield, with the result that he has thrown much light on several difficult problems, and simplified the geology of the Rand from end to end, more particularly where the so-called breaks occur. Although boring and mining operations have clearly proved the continuity of the Van Ryn reef with the Main Reef series, and the occurrence of the overlying reefs in their proper position when compared with the rest of the Rand, attempts have from time to time been made to raise doubts as to the true age of the reef now so extensively opened up on the Far East Rand. Dr. Mellor has shown that the Van Ryn reef is no other than the Main Reef Leader, and the slate foot-wall which to many seemed to be the greatest bugbear to the task of placing the true geological age of the Van Ryn reef, really constituted and supplied the key to the whole position. Now that the Geological Survey has given its verdict after careful examination of the whole goldfield, we may hear less about the duplications of the Rand and the failures to recognize the Government line of reef as well as the Main Reef series itself, not to mention the Bird and Kimberley series, which afford such a reliable key to unlock the geological position. The verdict of Dr. Mellor that the Van Ryn reef is no other than a member of the Main Reef series was never doubted by the majority of mining engineers and geologists on the Rand.

RAND TECHNICAL INSTITUTES.—Mr. E. J. Way, the retiring president of the South African Institution of Engineers, in his valedictory address, made some interesting remarks about the apathy of members in discussing and reading papers as well as the disappointing attendances at the meetings. A similar state of apathy seems to have come over the other Rand societies, an apathy which seems, if possible, more marked during the last twelve months than ever. There is no doubt that the explanation advanced by Mr. Way to the effect that members are afraid to discuss or read papers for fear of offending those in authority over them is in a good many instances quite true, and no denials however emphatic will remove the impression that some risk exists in reading or discussing a paper at a meeting of a technical society on the Rand.

SAN FRANCISCO.

METALS.—The increased prices for metals have caused many changes in the mineral industry of the United States and more are likely to result. Among other things it has caused a resumption of antimony mining and smelting. During the three or four decades preceding the present one a limited amount of antimony was produced in the United States. In Sevier county, Arkansas, numerous deposits occur and were worked at a small or no profit in the period between 1870 and 1900. In Utah, similar deposits are found, on one of which a mill was erected a few years ago, but soon closed down. In Oakland, across the bay from San Francisco, a smelter was in operation about 1880 and at desultory intervals thereafter. Gradually the whole business died out, as it became abundantly clear that at the price which the metal has averaged for the past decade there was no profit to be made in producing it in this country. The antimony market in New York became a pit for speculators, even the consumers taking a hand in the speculation game. Now that the metal is selling for about six times its normal price everybody who knows where to find an antimony mine is figuring on making some money out of it. The chief trouble is that few in this country know how to turn antimony ore into saleable metal. The Chapman Smelting Works has started a plant in San Francisco, but is having difficulties in getting furnacemen. Ore is being shipped from various points in Alaska, Idaho, and California, but no figures are available as to the quantity and quality of metal yet produced. Several other companies are on the verge of getting into the antimony business. It has its drawbacks, for no one can know how long the price of the metal will remain high, both because of the uncertainties of the war, and also because the Chinese producers, working ores from rich and extensive deposits, are undoubtedly increasing their output also. The supply may therefore soon catch up with the demand and the cream of the profit be skimmed away, leaving some of the would-be producers with equipment that has not yet paid for itself.

The zinc situation has its humorous aspects, in that although the price of metal and ore has gone to undreamed of figures, nobody seems to be satisfied with it. The ore sellers think they are not getting paid as much as they should for their ore on the basis of the price of spelter, and the producers of low-grade ore are in insurrection, for they cannot sell their ore at all, the smelters naturally refusing to put 40% ore into their retorts when they can get 60% material, corresponding to a 50% greater output per day. The smelters are raising objections to having to buy ore at high prices that will not be turned into metal for two or three months, when the price of spelter may conceivably be half what it now is. And now the miners in the Joplin district have gone on a strike for higher wages, on the ground that they have a right to some share in the increased prices for the ore. Joplin has been singularly free from labour troubles in the past, and the Western Federation of Miners has never been able to attain any hold there. Relations between employer and employee have been simple because the operations in the district are on a small scale, and a man who is working for wages now may be mining for himself a few weeks later; therefore, there is no sharp contrast between a labouring class and an employing class. Presumably no sense of class distinctions yet exists, and the strike is merely a move on the part of the persons who are in no position to benefit from the higher prices, to force a 'divi' from those who are. It will probably be settled without any trouble by giving the desired increase of wages. Incidentally, it may be mentioned that those copper companies that have a sliding scale of wages, based on the price of copper, have had to extend the scale upward in order to provide for the prices now ruling.

The New Jersey Zinc Company, the largest of the American zinc mining and smelting companies, is benefiting from the present situation in undisturbed placidity. Its product is chiefly made from its own ore, so it is not vexed by differences of opinion as to the proper ratio between ore and spelter prices. The ore in its big mine at Franklin Furnace, New Jersey, is entirely free from lead and other harmful impurities, so that for making brass it has the highest reputation and sells itself. In the last few months 'Horsehead' spelter, as its product is known to the trade, has commanded a price 6 cents per pound over ordinary spelter. A by-product of its mine is the production of spiegeleisen. Most of the ferro-manganese alloys used in the United States are made from imported ores, or else imported as ferro-manganese; this company is the chief source of domestic supply. The interruptions to which imports have been subject have raised the price of ferro-manganese alloys and so the spiegeleisen business has become unusually profitable as well. The New Jersey Zinc Company had a capital of $10,000,000; it is said to have accumulated a surplus of undistributed profits of $25,000,000 in the last few years, although its recent dividends have been $50 per share per year. Last month the capitalization of the company was increased to $35,000,000, presumably not because it needed any more money but because in the present state of American opinion toward large companies it is wise to pay smaller dividends on a larger capital. The company is also extending the scope of its operations and the increased capital can be allocated to this purpose. The company is one of the cleanest and best conducted of American enterprises, and is well advised to pursue a course which lessens the danger of public suspicion. Its present happy state forms a sharp contrast to the Australian zinc producers, that can turn out quantities of zinc concentrate but cannot sell it, under present conditions.

FLOTATION PROCESS.—Perhaps the most interesting of the new small copper mines in this country is the Engels, in Plumas county, California. It was discovered about 30 years ago and has been worked in a desultory fashion since that time, several hundred tons of high-grade ore having been shipped to Swansea for treatment. A few years ago a small smelter was built on the property, but was never even blown in, it having been discovered when too late that the mine was in a National forest and the government would not permit the operation of a smelter there. The ore cannot be successfully concentrated in the ordinary way, for it contains large quantities of magnetite, the resulting concentrate being too low-grade to stand the cost of shipping to the nearest copper smelter. Finally it was suggested that flotation would solve the problem, and large-scale tests demonstrated that this was true. The Minerals Separation company at one time had an option on the property, but was unwilling to meet the terms of the owners, who then went ahead and built a 200-ton Minerals Separation flotation plant for themselves. This proved conspicuously successful, and the company is now financing the expansion of its operations out of its current earnings. This is the only copper mine in the United States that uses flotation alone for the treatment of its ore. The mill was built at a remarkably low figure, having cost less than $250 per ton of daily capacity. The engineer in charge of operations, Edmund Jussen, has been remarkably successful in finding additional ore reserves in the mine, and it is now proposed to double the mill capacity. The ore being milled contains 3·8% copper, chiefly in the form of bornite, chalcocite, and chalcopyrite, and a concentrate containing 40% copper is made. This is sent by railway to the smelter at Garfield, Utah. The mine is already an excellent example of successful modern work and gives good promise of developing into a large producer. Experiments are about to be made with the Trent system of agitation and aeration, now for the first time applied to flotation, and a good deal of interest will attach to the results.

ST. LOUIS

MISSOURI, as a great lead and zinc producing state, has benefited much from the high price of metals that has obtained in the past few months. It has also profited from the demand for manufactured goods, but even so would gladly exchange this apparent prosperity for peace. General business does not respond to the stimulus as had been hoped. Even those who have money do not seem ready to undertake new enterprises. The one exception perhaps is in zinc mining, and it is a pleasure to visit Joplin, just to be in a district where people are optimistic, cheerful, and ready to believe things are going right. It is small wonder that they feel so since 'jack,' long considered well sold at $40 per ton, now brings $110. Old mines and new ground are being re-opened throughout the Missouri-Kansas district. In the Miami district of Oklahoma, about 25 miles southwest of Joplin, conditions are equally encouraging. The Pitcher Lead Co., operating there, has drilled a lot of territory and found such quantities of ore that it has been determined to smelt zinc as well as lead. The company has accordingly leased the old Collinsville smelter near St. Louis, and will soon be producing metal. Whether this will be a permanent branch of its business is not announced, but as the company is one of the oldest and most solid in the state, it may be expected to follow the Granby, which, beginning with a lead smelter, is now also one of the important producers of spelter. The Rose Lake plant, built just before the war to commemorate fifty years of activity of the Granby company, has now settled down to regular production and is giving a good account of itself.

The lead mines have not been affected as much as the zinc mines. Lead rose to 7 cents per pound, and then dropped back quickly to 5½ cents, but even so it is nearly 2 cents above the average price for the last two years. This has upset many industries dependent upon lead. The white lead makers cannot afford to manufacture at that price, and painters will not buy white lead when it goes above 7 cents per pound. On the other hand the rise in price has meant much to the lead miners. To the St. Joseph Lead Co., for example, the added price will mean about $3,000,000 additional profit in a year, just about the amount necessary to pay its debts and straighten out the difficulties into which that company had fallen. No wonder shares have gone from $6 to $14. The St. Joseph is the world's largest lead producer. It and the other big companies in southeastern Missouri, with their 4000 tons per day mills, are working the disseminated ores at a rate that will make it necessary to look for additional fields before many years. Certain far-seeing St. Louis men are already drilling in Washington county where workable beds have been reported at 815 and 907 ft. in depth. The work is slow, as the heavy body of chert overlying makes drilling expensive, and the theory of the deposits formulated by the late E. R. Buckley while state geologist is adverse to the occurrence locally of lead under such cover. Others, however, believe that in this he was in error, and are glad to know that the matter is being tested. In the meantime the recovery in existing mills is being improved by the addition of flotation units, and costs are being reduced by better organization and cheaper power.

The importance of Missouri as a metal mining state is emphasized in a report upon 'Silver, Copper, Lead and Zinc in the Central States in 1914' by B. S. Butler and J. P. Dunlap, just issued by the United States Geological Survey. The total value of the ores of these metals produced in Missouri in 1914 was $25,874,864. The recoverable lead content of Missouri concentrates sold within the year amounted to 35½% of the smelter production of primary lead derived from domestic ores in the United States. The zinc formed 30·9%. That Missouri is a copper producer is not often remembered, but in 1914 the output was 44,463 lb., despite the fact that the mines of the principal producer, the North American Lead Co., were not operated. With the copper in the mines mentioned is a small amount of cobalt and nickel. The silver credited to the state, and amounting in 1914 to 61,168 ozs., is obtained from the lead ores. As it only occurs in the proportion of about one ounce per ton of lead concentrate, it is not in itself worth refining.

PERSONAL.

H. DOUGLAS ALLEN has returned from Nigeria.

A. F. S. ANDERSON is on the metallurgical staff of the Eastern Smelting Co., Penang.

H. M. BARNEBY has returned from West Africa.

H. C. BELLINGER is about to pay another visit to Chile.

W. B. BLYTH has left West Australia for Rhodesia.

J. H. BOSANKO has left for Southern India.

WALTER LYMAN BROWN has resigned his position as manager of the Abbontiakoon mine and has returned from West Africa.

J. N. BULKLEY has been appointed consulting mechanical and electrical engineer to the Canadian Mining & Finance Company.

J. MORROW CAMPBELL left by the *Philadelphia* on July 17 on his way to Canada.

A. SPENCER CRAGOE has left for the north of Spain.

FRANCIS DRAKE has gone to Rhodesia temporarily.

E. FERRARIS has been spending a holiday in Switzerland.

DONALD GILL has received a commission in the Royal Garrison Artillery.

F. W. HARBORD has been appointed honorary adviser in metallurgy to the Munitions Committee.

C. W. HAYES is seriously ill at Washington, D.C.

GEORGE T. HOLLOWAY has been appointed chairman of the Ontario Government Nickel Commission, and leaves for Canada on August 20.

H. C. HOOVER has been in Belgium, Germany, and France lately, as Chairman of the Commission for Relief in Belgium.

ARCHIBALD JONES has been appointed manager for the American Zinc & Chemical Co. at Langeloth, Pennsylvania.

H. EWER JONES has gone to Rhodesia to make an inspection of the Globe & Phœnix on behalf of the Amalgamated Properties of Rhodesia.

FREDERIC KEFFER has moved his office from Greenwood, British Columbia, to Spokane, Washington. He has entered into partnership with Henry Johns.

E. S. KING has been appointed consulting engineer to the Cornish Tin Sands, Limited.

R. N. KOTZE and DAVID WILKINSON are members of the Government Commission appointed to make investigations regarding earth tremors on the Rand.

E. MAXWELL-LEFROY has returned from India.

H. G. MOUNTAIN has received an appointment with the Brakpan Mines Ltd.

C. H. OLIVER has gone to West Africa.

WILLIAM B. PHILLIPS has been elected president of the Colorado School of Mines.

H. E. POPE has received a commission in the Royal Garrison Artillery.

THOMAS T. READ has resigned from the staff of the *Mining and Scientific Press* to accept a position with the Engels Copper Company.

R. J. D. RICHARDSON has a commission in the Royal Garrison Artillery and is stationed near Rawal Pindi, India.

EDGAR RICKARD visited Belgium recently as Honorary Secretary of the Commission for Relief in Belgium.

WILLIAM ROBERTS has left for Eastern Siberia.

THOMAS P. SHARMAN has returned from Colombia.

W. STAMM has moved his office from 25 College Hill, to 63 Queen Victoria Street, London, E.C.

WILLIAM SELKIRK has returned from a visit to Petrograd and the Sissert mine.

ERIC J. STAREY is with the Motor Transport Corps in British East Africa.

ARTHUR THOMAS is making a tour of the principal mining districts of Russia and Siberia.

J. E. THOMAS, metallurgist at Simmer Deep, has been elected president of the Chemical, Metallurgical, and Mining Society of South Africa.

W. E. THORNE is on the Lenskoie staff, at Bodaibo, Siberia, having been granted a temporary leave of absence by the Consolidated Gold Fields.

GEORGE H. THURSTON, engineer to the Consolidated Gold Fields of South Africa, sailed for New York on August 7.

SCOTT TURNER has returned to Tromsoe, Norway, from Petrograd.

S. DAWSON WARE has returned from the Belgian Congo.

A. R. WILLIAMS has been appointed manager of the Mouramba copper mine, New South Wales.

C. M. WILKINSON has left Kalgoorlie for the Pahang Consolidated, Malay Peninsula.

C. HERBERT WILSON is home on leave from Northern Nigeria.

POPE YEATMAN has moved his office to Room 3533, at 120 Broadway, New York.

METAL MARKETS

COPPER.—The course of the market has been steadily downward, and at £72. 10s. for three months copper the fall during the month registers no less than £12. Buyers have in consequence held off the market, and have undoubtedly gained by so doing. Their activities are not permanently lessened, however, for both in America and the Old World factories that can be put on munition-work continue to run at full pressure. A revival in demand is accordingly to be looked for whenever prices begin to steady. American producers well sold ahead were inclined to show their indifference to the course of the market, and for long refused to meet the competition of second hands. Their independence, however, has been shaken by the long drop in prices, and the quotation for electrolytic has come down to 18¾ or 19 cents f.o.b. New York. The decline is not expected to go much farther. Already buyers are showing an inclination to come in, and may be expected to do so substantially when the signs of an arrest in the downward course of prices become more manifest. The American output is steadily growing, but there is no sign of accumulation of stocks, and the power of absorption of the metal is likewise expanding. On how far this process can continue will depend the future of the market. Japan has been rather a free seller and, with the suppression of German selling houses there, is sending her own emissaries to Europe to be in direct touch with the markets. This is a development that may lead to important changes. If with their cheap labour they should resolve to send us manufactured copper in place of the raw material, trade conditions may be seriously affected.

Average prices of cash standard copper: July 1915, £76. 1s. 11d.; June 1915, £82. 13s. 7d.: July 1914, £60. 13s.

TIN.—This market has been characterized by weakness throughout the month. There has never been an acute fall, but the tendency has been steadily downward. The cash price has fallen from £170. 10s. to £156. At the same time the backwardation has disappeared, and the position made sounder by the warehousing of good quantities in London. The premium on Straits tin is consequently lower. The shadow of the coal dispute has affected buying by Welsh tinplate manufacturers. On the other hand, there has been a moderate but continuous demand from our Allies. America has been distinctly disappointing; trade there is unprecedentedly good, but fresh buying has been conspicuously absent. There must be all the greater volume of buying when consumers have made up their minds to replenish stocks. Shipments from the Straits for August are estimated at only 5000 tons. A large portion of this will go direct to America. Chinese producers have shown little activity in selling, but they show signs of seeking a market through new channels. The Straits and Java have been continual sellers throughout the month.

Average prices of cash standard tin: July 1915, £167. 5s. 10d.; June 1915, £167. 17s. 3d.; July 1914, £142. 10s. 4d.

SPELTER.—Prices show some decline, and toward the end of the month business was reported at £80, while the nominal quotation has been reduced from £100 to £85. The volume of business put through is inconsiderable, as manufacturers are unwilling to buy ahead. America is above our parity; quotations have been lowered, but not enough to attract buyers. Various schemes are mooted to start new spelter works here, but the difficulties seem insurmountable.

Average prices of good ordinary brands: July 1915, £97. 5s.; June 1915, £100. 12s. 3d.; July 1914, £21. 6s. 7d.

LEAD.—Lead has been steady, and the price remains high. Home demand has fallen off considerably in the absence of fresh requirements for munitions, while for ordinary industrial needs inquiry has been conspicuously slow for months past. For Russia and Italy active business is being done. The tonnage reaching the London market is quite considerable, but this is due in part to the arrival of detained cargoes. During August arrivals will probably fall off. The American price has been lowered to 5¼ cents; this is still far above the level of the London market.

Average prices of soft pig lead: July 1915, £24. 12s. 2d.; June 1915, £25. 4s. 1d.; July 1914, £18. 8s. 5d.

ANTIMONY.—The market for antimony is restricted, and the quotation, £115 to £125, for English brands is purely nominal. Resuscitation of production in America is hindered by the absence of skilled metallurgists and workmen. The only free supply comes from China.

QUICKSILVER.—The price of Spanish quicksilver continues to rise and the quotation is £18 per flask of 75 lb.

PLATINUM.—185s. per oz., nominal.

BISMUTH.—10s. per lb.

COBALT.—7s. 6d. per lb.

CADMIUM.—7s. 6d. per lb.

ALUMINIUM.—The price continues to advance and the quotation is £165 to £175 per ton, a rise of £25 on the month, and being just double what it was before the war. The metal is sought as a constituent of alloys in substitution for zinc.

CHROMIUM.—Chrome ore is quoted at from 105s. to 115s. per ton on the basis of 47% to 50% chromic acid, delivered in London. Ferro-chrome, 4 to 10% carbon, £25 to £28 per ton on 60% basis with a scale of 10s. per unit.

NICKEL.—The price has hardened to £225 per ton.

MOLYBDENUM.—The market for molybdenum exhibits none of the excitement of a few months ago. The nominal quotation remains at 115s. to 120s. per unit for mineral containing not less than 90% MoS_2. Ferro-molybdenum, 18s. per lb. of molybdenum contained.

MANGANESE.—The market for manganese ores is greatly restricted. Quotations are 21½d. to 22½d. per unit for 50% Indian ores, and 28d. per unit for 50% Brazilian ore, delivered at English ports. No ore, of course, comes from the Caucasus.

IRON.—The quotations for pig iron have not greatly altered during the month, No. 3 Middlesbrough remaining at 67s. per ton, and Cumberland hematite at 95s. per ton. Steel rails £9. 2s. 6d. per ton, ship plates £9. 15s. to £10. 15s. per ton. Spanish ore delivered in Great Britain 25s. 9d. per ton.

TUNGSTEN.—The price of wolfram and scheelite continues to advance and the quotation now stands at 55s. per unit for material containing 70% WO_3. Tungsten metal is quoted at from 7s. to 7s. 6d. per lb.; ferro-tungsten 80 to 90% metal low in carbon is quoted at 6s. 6d. per lb. of tungsten contained.

SILVER.—The silver market continues to be inactive and the price has not moved far from 22½d. per oz. standard. Demand in the East has been small, particularly in India, where agriculture has been hindered by drought. Rain having fallen, a revival in the demand for silver may be experienced.

QUOTATIONS

of leading mining shares on the London Market.
Shares are £1 par value except where otherwise noted.
Quotations are given in shillings.

GOLD, SILVER, DIAMONDS:	July 1 1914	July 1 1915	Aug. 3 1915
Rand:			
Bantjes	14	9	9
Brakpan	51	54	60
Central Mining (£12)	160	130	125
Cinderella	6	3	3
City & Suburban (£4)	52	47	42
City Deep	66	60	62
Consolidated Gold Fields	43	24	25
Consolidated Langlaagte	35	37	37
Consolidated Main Reef	18	19	19
Crown Mines (10s.)	120	82	85
D. Roodepoort Deep	17	17	16
East Rand Proprietary	33	26	26
Ferreira Deep	47	44	41
Geduld	23	28	29
Geldenhuis Deep	26	21	21
Gov't Gold Mining Areas	23	21	22
Heriot	55	64	56
Jupiter	5	6	6
Kleinfontein	24	23	23
Knight Central	8	6	7
Knight's Deep	35	29	27
Langlaagte Estates	20	19	19
Luipaard's Vlei	10	7	7
Main Reef West	7	7	6
Meyer & Charlton	115	109	110
Modderfontein B	89	101	105
Modder Deep	58	84	84
Modderfontein, New (£4)	263	290	294
Nourse	27	22	23
Rand Mines (5s.)	120	92	89
Randfontein Central	17	11	11
Robinson (£5)	57	35	35
Robinson Deep	33	25	22
Rose Deep	43	37	35
Simmer & Jack	12	11	10
Simmer Deep	1	1	1
Springs	11	21	22
Van Ryn	67	61	55
Van Ryn Deep	47	51	51
Village Deep	40	36	37
Village Main Reef	40	30	29
Witwatersrand (Knight's)	71	65	61
Witwatersrand Deep	48	33	32
Wolhuter	14	11	11
Rhodesia:			
Cam & Motor	19	14	11
Chartered	17	9	10
Eileen Alannah	11	6	6
Eldorado	18	14	10
Enterprise	9	5	5
Falcon	14	8	7
Giant	14	7	5
Globe & Phœnix (5s.)	32	27	26
Lonely Reef	27	23	21
Shamva	46	37	34
Wanderer (5s.)	3	1	1
Willoughby's (10s.)	7	5	5
Others in South Africa:			
De Beers Deferred (£2 10s.)	330	207	197
Glynn's Lydenburg	11	10	10
Jagersfontein	78	52	52
Premier Diamond Defer'd (2s. 6d.)	152	95	85
Sheba (5s.)	4	4	3
Transvaal Gold Mining Estates	37	36	33
West Africa:			
Abbontiakoon (10s.)	8	8	8
Abosso	14	7	7
Ashanti (4s.)	16	15	16
Broomassie (10s.)	2	1	½
Prestea Block A	15	11	10
Taquah	15	15	14
West Australia:			
Associated Gold Mines	7	5	4
Associated Northern Blocks	7	4	4
Bullfinch	6	6	6
Golden Horse-Shoe (£5)	43	47	45
Great Boulder Proprietary (2s.)	14	14	14
Great Boulder Perseverance	2	1	1
Great Fingall	9	3	3
Ivanhoe (£5)	50	47	44
Kalgurli	36	34	31
Sons of Gwalia	23	16	16
Yuanmi	3	2	2

GOLD, SILVER, *cont.*	July 1 1914	July 1 1915	Aug. 3 1915
Others in Australasia:			
Blackwater	16	15	15
Consolidated Gold Fields of N.Z.	13	11	11
Mount Boppy	10	10	10
Mount Morgan	52	49	44
Progress	10	7	5
Talisman	33	21	21
Waihi	42	39	37
Waihi Grand Junction	25	23	21
America:			
Alaska Treadwell (£5)	162	147	140
Buena Tierra	15	13	8
Butters Salvador	20	15	15
Camp Bird	9	5	4
Canadian Mining	—	8	8
Casey Cobalt	13	7	6
El Oro	14	7	7
Esperanza	15	8	8
Kirkland Lake Proprietary	74	27	27
Mexico Mines of El Oro	97	67	67
Oroville Dredging	10	14	15
St. John del Rey	15	15	14
Santa Gertrudis	11	7	7
Tomboy	22	22	20
Tough-Oakes	28	8	6
Russia:			
Lena Goldfields	43	35	32
Orsk Priority	7	8	9
India:			
Champion Reef (2s. 6d.)	11	11	10
Mysore (10s.)	93	86	76
Nundydroog (10s.)	27	25	25
Ooregum (10s.)	23	25	25
COPPER:			
Anaconda (£5)	126	149	149
Cape Copper (£2)	60	62	50
Chillagoe (10s.)	1	½	½
Cordoba (5s.)	6	3	3
Great Cobar (£5)	3	2	1
Great Fitzroy (5s.)	½	¼	¼
Hampden Cloncurry	27	33	30
Kyshtim	55	42	35
Messina (5s.)	15	14	14
Mount Elliott (£5)	55	65	60
Mount Lyell	23	25	23
Rio Tinto (£5)	1355	1170	1100
Sissert	25	19	19
South American Copper (2s.)	22	15	11
Spassky	52	42	40
Tanalyk	78	41	35
Tanganyika	40	27	24
LEAD-ZINC:			
Broken Hill:			
Amalgamated Zinc	28	26	24
British Broken Hill	36	23	22
Broken Hill Proprietary (8s.)	36	45	44
Broken Hill Block 10 (£10)	32	21	21
Broken Hill North	52	42	39
Broken Hill South	175	145	137
Sulphide Corporation (15s.)	26	20	17
Zinc Corporation (10s.)	19	14	12
Asia:			
Burma Corporation	28	38	34
Irtysh Corporation	—	35	30
Russian Mining	31	15	14
Russo-Asiatic	151	87	75
TIN:			
Nigeria:			
Bisichi	8	6	5
Jos (5s.)	5	4	4
Kaduna (5s.)	15	15	15
Naraguta	17	15	12
N. Nigeria Bauchi (10s.)	3	2	2
Rayfield	5	4	3
Ropp (4s.)	100	16*	12*
Other Countries:			
Aramayo Francke	31	27	27
Briseis	5	5	4
Cornwall Tailings	17	15	15
Dolcoath	11	7	6
Geevor (10s.)	5	4	2
Gopeng	27	29	26
Mawchi	20	4	6
Pahang Consolidated (5s.)	7	7	6
Renong Dredging	36	20	20
Tekka	55	60	60
Tronoh	26	30	27

* Denomination of shares recently changed from £1 to 4s.

PRECIS OF TECHNOLOGY

[*Copies of the original papers and articles mentioned under this heading can be obtained on application to the Technical Bookshop, Salisbury House, London, E.C., the book department of The Mining Magazine.*]

Australian Lead and Zinc Production. — The *Australian Mining Standard* for June 3 reproduces a number of tables relating to the production of lead and zinc concentrates at Broken Hill, together with notes relating to the destination of the various products. These tables were prepared by the Attorney General of the Commonwealth for presentation to the House of Representatives when the Enemy Contracts Annulment Bill was introduced. The figures relate to the completed years before the outbreak of war.

LEAD CONCENTRATE PRODUCED AT BROKEN HILL.

This table gives the yearly outputs of the companies, but the individual years do not correspond.

	For year ended :	Output of Lead Conc'n-trate. Long Tons.	Gross Contents	
			Silver. oz.	Lead. Long Tons.
Zinc Corporation	Dec. 31, '13	30,680	306,800	20,313
Sulphide Corporation	June 30, '14	34,317	1,181,681	22,770
B.H. Proprietary	May 31, '14	61,755	1,607,025	35,544
B.H. Block 14............	March 31, '14	*13,470	198,358	3,385
B.H. Junction	July 31, '13	7,665	194,800	4,435
B.H. Junction North .	March 31, '13	31,980	1,055,360	17,150
Amalgamated Zinc. ..	June 30, '14	1 491	64.551	782
Total smelted locally		181,358	4,608,575	104,379
B.H. Block 10......	March 31, '14	13.189	423,944	8.563
B.H. South	June 30, '14	56.339	1,305,475	38,461
North B.H.	June 30, '14	54 402	1,257,035	37,839
British B.H.	June 30, '14	31,441	767,292	19,379
Total exported		155,371	3,753,746	104,242
Grand Total...........		336,729	8,362,321	208,621

*Carbonate.

OUTPUT OF ZINC CONCENTRATE AT BROKEN HILL.

The annual periods do not cover the same 12 months

	Year ended	Output of Con-centrate Tons	Gross Metal Content		
			Silver oz.	Lead Tons	Zinc Tons
Zinc Corporation	Dec. 31, '13	142,828	1,389,822	14,760	52,222
Sulphide Corporation	June 30, '14	64,798	1,075,494	5,396	29,798
B.H. Proprietary	May 31, '14	81,659	1,061,567	5,564	37,563
B.H. Junction North	March 31, '14	15,914	238,710	?	170,919
Amalgamated Zinc	June 30, '14	153,865	1,294,785	8,629	69,795
Totals		459,064	5,060,378	34,349	196,062

NOTE.—The Zinc Corporation produces zinc concentrate from its own mine and from purchased tailing; Amalgamated Zinc produces zinc concentrate from tailing purchased from the North, South, and Block 10 mines.

As regards the destination of the lead concentrate, the Broken Hill Proprietary smelts its own at Port Pirie, together with that from the Zinc Corporation, Junction, Junction North, and Amalgamated Zinc. The Sulphide Corporation smelts its product at Cockle Creek, near Newcastle, New South Wales, together with that from Block 14. The Proprietary refines its lead bullion, and the Sulphide Corporation sends the bullion to England for refining. The contracts on which the lead concentrate is despatched are usually for short periods only, in this way differing from the Australian zinc and copper contracts. Of the concentrate exported to the continent of Europe, that produced by the Block 10 and North Broken Hill companies is bought by Brandeis, Goldschmidt & Co., that produced by the Broken Hill South by the Australian Metal Co., which was the local representative of Henry R. Merton & Co. and the Metallgesellschaft, and that produced by the British Broken Hill company by Beer, Sondheimer & Co. The Block 10 contract expires in 1916 and the British in 1917. The South contract has been cancelled by mutual arrangement, and the North contract expired at the end of 1914. As a foot-note to the table we may state that the lead concentrate produced by the Amalgamated Zinc is obtained by de-leading zinc concentrate.

With the exception of a small amount treated by the Proprietary at Port Pirie and by the Sulphide Corporation at Seaton Carew, England, the whole of the zinc concentrate is sold to German firms, of which the Metallgesellschaft, Aron Hirsch und Sohn, and Beer, Sondheimer & Co., work in harmony, controlling the output of the refined metals. These three are usually called the ' Trio ' group. The Zinc Corporation's contracts are with Aron Hirsch, and extend to 1919. The Sulphide Corporation's contracts are with Beer, Sondheimer & Co., and extend to 1918 and 1919. The Proprietary has two contracts with Beer, Sondheimer & Co., expiring in 1916 and 1921. The Junction North's chief contract is with Aron Hirsch, and extends to 1921, a smaller amount going to Brandeis, Goldschmidt & Co. The Amalgamated Zinc has a contract with the Australian Metal Co., representing Henry R. Merton & Co. and the Metallgesellschaft, expiring in 1919.

Selective Flotation.—The *Mining and Scientific Press* for June 26 contains a paper on selective flotation by O. C. Ralston, of the Department of Metallurgical Research in the University of Utah, and published by permission of the United States Bureau of Mines. This paper contains a critical consideration of the literature on the subject, chiefly United States patent specifications, and deals with ideas and suggestions rather than with records of performance. His comments on some of the processes are distinctly helpful, though on the other hand some disadvantage has arisen owing to the restricted scope of the author's researches.

One of the earliest proposals for selective flotation was that made by A. E. Cattermole (British Patent 26,296 of 1902, and United States Patent 763,259). This was in connection with his process for agglomerating sulphide particles by means of oil into masses sufficiently large to sink by their own weight, and was intended for preferentially breaking down the affinity of the various sulphides for the containing oil. The masses were subjected to the action of an alkaline emulsifying solution, the strength of which could be increased; thus the sulphide particles having the lowest affinity would be released first, and the others subsequently, in order of their increasing affinity. Thus, in a complex ore containing zinc, copper, and lead, the zinc blende would be released by a solution containing 0·75% soap and 0·75% alkali, while any associated chalcopyrite would be removed by a solution of double strength, leaving the blende behind. This process was proposed in the days when comparatively large amounts of oil were employed in flotation, and is usually overlooked nowadays, when the flotation principle involves the use of so much smaller a proportion of oil. Mr. Ralston, however, draws attention to the process, because possibly it may be applicable to modern flotation froths.

The next patent in chronological order quoted by the author is that of H. A. Wentworth, of Boston, 938,732 of 1909. This patent describes what is known as the Horwood process, giving the mixed sulphides a short roast at a dull red heat sufficient to form compounds on the surface of galena, pyrite, and chalcopyrite, that are unamenable to flotation, and leaving the zinc blende unaffected. In this way the blende can be floated, while the coated sulphides fall. Owing to the author having confined his reading to United States specifications, he gives an incorrect impression as to the date of Horwood's invention, for he quotes only the American patent 1,020,353 of 1912. The Australian patent was dated January 13, 1909, and his British patent January 25 of the same year. Moreover, full technical details were published in *The Mining Magazine* for January 1910, and in the *Engineering and Mining Journal* for February 26, 1910. The process was developed at the Zinc Corporation's works, and is employed there at present in connection with the selective treatment of slime. The author quotes the improvement in Horwood's process (United States Patent 1,108,440 of 1914), whereby more of the silver is obtained in the lead concentrate. Horwood found that by giving the materials a wash in water for the removal of soluble salts before roasting an effective separation of the lead and zinc constituents can be obtained with a lower degree of sulphatization, with the result that a higher percentage of the silver content is unfloatable and remains behind with the lead. It is well to add to Mr. Ralston's notes the record that Mr. Horwood fully described this modification of the process in a paper read before the Australasian Institute of Mining Engineers in 1913.

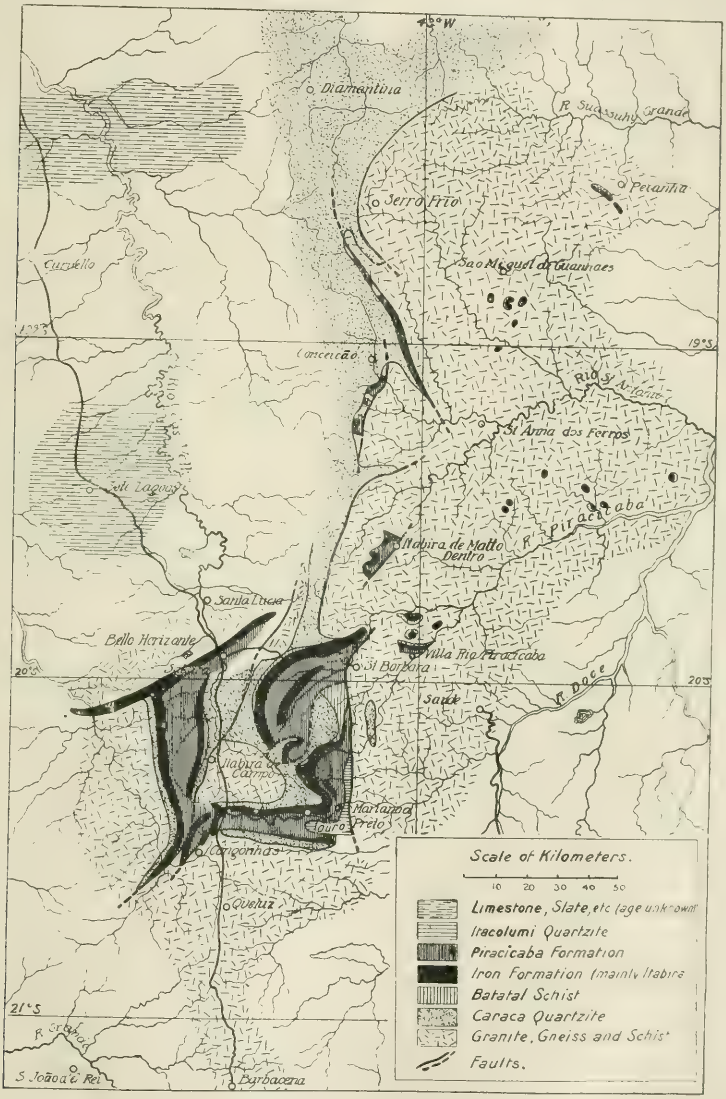
An American patent following Wentworth's was that of A. S. Ramage, 949,002 of 1910, assigned to the Chemical Development Co., of Colorado. This process used the same 'fractional roasting' as Wentworth's, and the material was then treated in a hot acid bath. The process would appear to be a combination of Wentworth's, or Horwood's and Potter's processes. The patentee described a particular application to Cobalt ores, whereby the sulphides and sulpharsenides are floated, leaving the silver in the gangue. The next patent in order of time was a second by H. A. Wentworth (United States Patent 980,035), who extended the method of deadening certain surfaces so as to include treatment by chemicals, and he mentions particularly the employment of chlorine gas for this purpose. Mr. Ralston gives no record of the process proposed by Kenneth A. Mickle, of the Great Fitzroy mine, whereby ferric chloride is employed for deadening the surface of the galena. This process is on somewhat similar lines to that described in Wentworth's second patent. Mr. Mickle's process was described in the *Australian Mining Standard* for May 2, 1912.

The first selective process not involving a preliminary fractional roast is that of F. J. Lyster (Australian patent 5040 of 1912), in which the preferential attraction of eucalyptus oil for galena in alkaline solutions of certain salts is employed. Mr. Ralston notes Leslie Bradford's process in use at the Broken Hill Proprietary, where blende is preferentially floated in a hot acid solution of common salt. He does not mention T. D. Owen's process, which is on much the same lines as Lyster's. As we have on previous occasions given particulars of these three processes, we omit Mr. Ralston's remarks, and pass to his account of Nutter and Laver's patent (United States Specification 1,067,485 of 1913), which has not previously received the attention it deserves. These two investigators, in seeking to improve the separation of the sulphides, found that when the coarser portions of easily floated sulphides are raised by the froth they are accompanied by the finer portions of the less easily floated sulphides and also by the finest of the gangue matter. The inventors therefore take each froth and send it to classifying apparatus, where the classification action has the effect of separating the various sulphides and the gangue. For instance, in treating an ore containing chalcopyrite, galena, and blende, the first froth, using cresol and no mineral acid, contains most of the chalcopyrite, and not much of the galena and blende. After the removal of this froth, sulphuric acid is added to the pulp and another agitation given, this time the greater portion of the galena being raised. Finally, by the addition of oleic acid, the zinc mineral is raised, together with the unduly large particles of galena and chalcopyrite that were too heavy to respond to the earlier treatments. By a subsequent treatment by classification of each of the three products a further separation of the constituent sulphides can be effected.

The last process to be described by Mr. Ralston is that invented by H. H. Greenway and A. H. P. Lowry (United States Specification 1,102,738 of 1914). According to this process the mixed sulphides are subjected to a treatment by a weak solution of a bichromate. This treatment is stated to improve the separation of the sulphides by the bichromate making certain of the sulphides less amenable to flotation. Mr. Ralston calls for further information as to the particular application of the process.

Geology of Minas Geraes, Brazil.—In the *Journal of Geology* for May-June, E. C. Harder and R. T. Chamberlin discuss the broad features of the geology of this State, as determined in the course of their surveys of the Brazilian iron ore deposits. Their own wide experience, both having formerly been members of the United States Geological Survey, and the time devoted to the work, extending over more than two years, warrants confidence in their conclusions. The area studied covers the gold, diamond, and iron deposits of eastern Brazil. The authors point out that eastern South America, as well as eastern North America, was deformed by mountain-making forces before the close of the Paleozoic age, and that this period was followed by long continued erosion, which base-levelled the mountains. Later, successive wide-spread uplift produced low plateaus, out of which rejuvenated streams have carved the present mountains. There are many and close analogies between the Serra do Espinhaço, the backbone ridge of eastern Brazil, and the Appalachians of the eastern United States. The Serra consists of quartzite, schist, iron formation, and limestone, while the east of it is a great plain where, under scattered sedimentary outliers, is a dominantly igneous complex, presumably of Archean age. At the ocean border are small areas of Mesozoic and Tertiary sediments. Appropriate place names are given to the various formations as follows, from top downward: Tertiary and Quaternary—river gravels, Tertiary clay and lignite, canga (recomposed iron breccia) deposits; Mesozoic and early Tertiary—Diamantina conglomerate; probably Algonkian—Itacolumi quartzite, Piracicaba schist and quartzite, Itabira iron formation, Batatal schist, Caraça quartzite; probably Archean—gneiss, granite, schist. The distribution of these formations is shown on the accompanying sketch map.

The Caraça quartzite forms the main Serra. It consists of quartz grains and white mica, and varies in thickness from 30 to 1800 metres. On it rests the Batatal schist, originally a thin mud layer, now capped in part by a sheet of serpentinized eruptive rock, originally a basic lava. The possibility of this being the source of the great Itabira iron formation which shore line. The formation shows marked differences in thickness from point to point, reaching a maximum of 1200 metres. It is interpreted as a delta deposit. The Piracicaba formation following represents original muds, with lines of quartz sand, iron oxide, and calcium carbonate, now become quartz schist, quartzite, minor iron ore deposits, and limestone. Above



Geological Map of Minas Geraes, Brazil.

follows is considered but dismissed. The Batatal schist occupies a topographic trough paralleling the Caraça quartzite ridges. Outside the trough rises the secondary ridges or 'hog backs' made up of the Itabira iron formation. This is interpreted as a true primary formation. It consists of iron oxide and quartz which has merely undergone dehydration, making hematite from the ferric hydroxide originally laid down, as it is believed, through the action of iron bacteria in a period of low land relief and retreating this is the Itacolumi quartzite, thick but limited in area. None of these beds are fossiliferous, and their assignment to the Proterozoic is based upon structural and lithologic evidence. It is possible that they belong in whole or in part to the early Paleozoic. The region has been folded and faulted, great thrust and slice faults being recognized. The Diamantina conglomerate is found in patches on the truncated even crest of the Serra do Espinhaço and in hollows and depressions of the *chapadas*, upland plains representing the old peneplain. The pebbles are mostly of quartzite, with a few of iron formation, schist, quartz, basic igneous rock, and diamonds. With it are smaller amounts of sand, kaolin, and bauxite. In part these old high-level gravels have been rearranged in modern deposits along the present rivers. These occupy valleys carved in the old peneplain, probably in the Tertiary and Quaternary periods.

Large American Low-grade Copper Mines.—In the *Engineering and Mining Journal* for June 26, Percy E. Barbour gives statistical information relating to the ore reserves at the large low-grade copper mines in the west of the United States, usually called the 'porphyry' or 'disseminated' coppers. He includes in his tables the two great copper mines in Chile, in which American capital is interested, the Braden and the Chile or Chuquicamata. The total reserve is estimated at 1,125,000,000 tons, of which 744,000,000 tons is in the mines in the United States. Four years ago Mr. Barbour estimated the reserves in the latter mines at 447,000,000 tons, so that the resources have been nearly doubled, in spite of the large amount of ore mined. The average copper content is nearly 1·8%, and it is estimated that at present 70% of this is recovered. There is therefore a large margin for the flotation process. Over a quarter of the New Cornelia ore, belonging to the Calumet & Arizona, is carbonate, and a leaching plant is to be employed. The Chuquicamata ore is also treated by leaching. The total daily mill capacity of all the mines in the table is 74,150 tons, at which rate the reserves will last for 42 years. The Inspiration, New Cornelia, and Chuquicamata were not yet producing. The Chuquicamata plant is to be doubled before long. Mr. Barbour also gives an analysis of some of the results during 1914, but as the collapse of the copper market following the declaration of war interfered with the output, the figures are not truly representative, and we do not reproduce them here.

Ore Reserves at Large American Low-grade Copper Mines

(Short tons throughout).

	Tonnage Developed and Partly Developed	Copper Tenor of Reserves, %	Date of Estimate	Total Copper Contents, Tons	Total Copper Recoverable at 70% Extraction	Nominal Mill Capacity, Tons per Day
Utah Copper	342,500,000	1·45	Dec. 31, 1914	4,966,250	3,476,375	21,500
Nevada Consolidated	41,020,296	1·68	"	689,141	482,399	9,500
Chino	90,270,000	1·75	"	1,579,725	1,105,808	6,300
Ray Consolidated	74,765,789	2·214	"	1,655,315	1,158,721	6 650
Consolidated Copper Mines *(a)*	21,624,236	1·153	April 30, 1914.	249,327	174,529	None
Miami	36,500,000*(e)*	1·85	March 19, 1915	675,250	472,675	4,200
Inspiration *(b)*	97,143,000	1·63	Dec. 31, 1914	1,583,430	1,266,745*(d)*	7,500(c)
New Cornelia (Calumet & Arizona)	40,258,000*(g)*	1·51		607,896	425,527	4,000*(h)*
Braden *(f)*	78,000,000	2·5	Jan 31, 1914	1,950,000	1,365,000	4,500
Chile (Chuquicamata)	303,303,000	2·0	June 1, 1915	6,066,060	4,246,242	10.000*(i)*
Totals	1,125,384,321	1·779		20,022,394	14,174,021	74,150

(a) Includes Giroux. *(b)* Includes New Keystone and Live Oak. *(c)* To be increased to 15,000 tons by end of 1915. *(d)* Figured at 80% extraction as indicated by company's experimental flotation plant *(e)* Does not include 6,000,000 tons 2% oxidized ores for which treatment has not yet been decided. *(f)* It is expected that an official report to be issued at an early date will show reserves to be 110 000,000 tons with copper tenor slightly above 2·5%. *(g)* Of this total, 11,954,400 tons carbonate ores average 1·54% and 28,303,600 tons sulphide ores average 1·50% copper. *(h)* Mill being designed. *(i)* First unit being tuned up, construction of another 10,000-ton unit in hand.

Extraction of Vanadium.—The *Colorado School of Mines Magazine* for July contains a paper by A. F. Hallett describing the plant and process used by the Primos Chemical Co. at Vanadium, Colorado, for treating vanadium ore. The ore is a dissemination of roscoelite in sandstone, and contains from 1 to 3% of vanadium. Roscoelite is a vanadium mica. In the treatment process, the ore is mixed with rock salt and iron sulphide, in charges containing 1500 lb. of ore, 90 lb. of salt, and 30 lb. of iron sulphide Each charge is dried, crushed to 30-mesh, and roasted in McDougal or Wedge furnaces. The salt reacts on the roscoelite to form sodium vanadate. The iron sulphide is added to act as a fuel in the furnaces. The roasted material is sent to leaching vats The leaching system is so arranged that the content of the resulting solution shall contain 7 to 8 grammes of vanadium per litre. The leaching operation occupies about 36 hours. The solution is cooled and passed to precipitating vats, where iron sulphate is added in the proportion of 2·5 or 2·7 to 1 of vanadium during agitation with air. The agitation is continued for some hours. The precipitate is collected in a Kelly filter-press, and after drying, is sent to the refinery in Pennsylvania. The author gives full details of the methods of handling the solutions and of the construction of the plant.

Moisture in Mine Air.—The *Journal* of the South African Institution of Engineers for June contains a paper by Arthur C. Whittome on the influence of moisture in the air on mine ventilation. This paper contains much valuable tabular matter and diagrams aiding the calculation of the amount of oxygen in moist air at various temperatures and pressures, the weight of a cubic foot of air, the elastic force of dry air and water vapour, etc., from which can be deduced the effect of moisture on the circulation of ventilating currents. By means of these tables it is easy to calculate the velocities of currents in the upcast and downcast shafts under different conditions of moisture content, and the amount of oxygen per foot of air and per minute of flow. The general deduction is that the current is most rapid when the air in the downcast shaft is cool and dry and the air in the upcast warmer and fully saturated, and that the greatest weight of oxygen flows when these conditions obtain. Reversely, the difference in temperatures in the two shafts being the same as before, the smallest amount of oxygen passes when the air is perfectly dry in both shafts. The author also shows that circulation is retarded by spraying the air, the action being that the evaporation of the spray abstracts heat from the air. The discussion relates only to ventilation caused by natural means and not by mechanical methods. We have not space to reproduce the paper in full, and we recommend everyone interested in ventilation at depth to secure an original copy of it.

Another point raised by the author is the effect on the worker of moisture in warm air. He is of opinion that comparatively large quantities of water vapour are condensed in the lungs, which thus become waterlogged, and the water is not removed until the worker is in a dry atmosphere again. The author believes that this moistness has more adverse effect on the vitality of the worker than the presence of carbonic acid within certain limits. For this reason also it is desirable that the descending air should be as cool and dry as possible. Mr. Whittome's paper will raise much discussion, and will help to elucidate many problems relating to mining in depth.

Gold Refining at Ottawa.—In his presidential address before the Institution of Mining and Metallurgy in March, Sir T. K. Rose described the methods of refining gold bullion as practiced at the British, Australian, American, and European mints, detailing the chlorine-gas, electrolytic chloride (the so-called Wohlwill process), and sulphuric acid processes. He recorded that the chlorine-gas process is used in Australia, the electrolytic chloride in the United States and Canada, and the sulphuric acid in England and Europe, and that a modification was to be introduced in the Canadian mint at Ottawa whereby the chlorine-gas process was to be adopted in conjunction with the electrolytic chloride process. Details of the modified practice at the Ottawa plant are given by Ralph Pearson in a paper issued in the July *Bulletin* of the Canadian Mining Institute. The modification has been found necessary on account of the wide variation in the silver and base-metal contents of the crude gold submitted for treatment, coming from various parts of the Dominion. For instance, the Yukon gold contains as much as 20% silver and 3½% base metal. In other cases mentioned by Mr. Pearson, the bullion contained as much as 15% lead and 10% copper. It became obvious shortly after the Ottawa refinery was started in 1911 that the electrolytic method did not meet the requirements, and that other arrangements would be necessary for the treatment of the 'rough' gold. It was decided therefore to adopt the chlorine-gas method as a first treatment and if the fineness thus obtained, 995, was not sufficient, to treat by the electrolytic chloride process in order to raise the fineness from 999·7 to 999·9. Mr. Pearson describes the plant and process adopted, which does not differ greatly in principle from that originally devised by F. B. Miller in 1867, for the Sydney Mint. The process consists of passing gaseous chlorine through the melted bullion, the chlorides of the base metals being volatilized, the chloride of silver remaining in molten form, while the gold is unattacked. Though descriptions of the process are well known to specialists, it is suitable here to reproduce the account of the new plant at Ottawa.

The Miller chlorine-gas process is comparatively simple, requiring only a constant supply of chlorine-gas at a pressure of not less than 5 to 6 lb. per sq. in., melting furnaces employing either coke or oil, condensing chambers at the rear of the furnaces, and suitable pots, tongs, and moulds. At the Ottawa Mint, the chlorine-gas is delivered to the furnaces from steel cylinders, each holding 100 lb. of liquid chlorine at a pressure of 97 lb. per sq. in., at 20° C. The cylinders are placed in a brick cupboard, having a tightly fitting door and ventilating pipe passing to the furnace flue, and also a pipe communicating with the outside air, so that any accidental escape from the cylinders shall not find its way into the building. Two cylinders are used, connected by a common header to duplicate ½ in., 9 lb., lead pipes, and so arranged that either cylinder may be used on either pipe-line. The lead pipes are carried to points immediately above the furnaces, where glass stop-cocks are inserted for regulating the flow of gas, connected with the lead pipes by heavy rubber tubing. Two branch pipes are connected with a lead receptacle having three necks similar to a Woolff's bottle, the third neck holding a lead pipe connected to a glass tube which in turn is attached to a lead bulb, like an enlarged pipette. The lead vessel holds sufficient water to give a column 11 ft. in height, corresponding to a working pressure of about 5 lb. per sq. in. If the pressure should exceed this owing to a sudden shutting-off of the supply to several furnaces, the water is forced up into the lead bulb and the gas escapes outside the building, thus preventing any danger of bursting the rubber connections or blowing the liquid metal out of the crucible.

The furnaces are fire-clay cylinders 18 in. high, 14 in. diam., encased in sheet iron and having an inlet at the bottom for the atomized oil and air, and a small outlet, 3½ in. in length, 2 in. wide, placed 2 in. below the top for the escape of products of combustion, etc. The interior is cylindrical, 15 in. deep, 8½ in. diam. The furnace covers are of fire-clay, made in two parts having a 1 in. hole in the centre to allow the passage of the earthenware chlorine pipe. These furnaces burn crude fuel oil 0·86 sp. gr., at a pressure of 40 to 50 lb. per sq. in., and air at 2 lb. per sq. in The flame enters at a tangent and whirls round in a spiral, finally reaching the outlet at the top, which is connected by a short flue 9 in. long with the condensing chamber 5 by 4 by 20 ft. in length. This in turn is connected with a similar chamber running at right angles to the first one, 20 ft. long, 3 ft. 6 in. wide by 3 ft. high. From the end of the latter chamber the flue is carried to the foot of a washing tower, 20 ft. high and 30 in. diameter, and having a water spray attached to the centre of the top-piece. This tower is connected with a 12 in. earthenware exhaust-fan, driven by a 7½ hp. motor at 1000 r.p.m. propelling 4000 cu. ft. of air per minute. The bottom section of the tower stands in an earthenware tank to collect any material washed from the fumes by the water spray. The fumes resulting from the chlorination and all furnace gases are thus immediately drawn from the furnaces through the chambers, and pass up the washing tower against a spray of water before being blown out of the chimney.

The crucibles are those known as 4-pint chlorine pots and are made of clay, the outside measurements being: height 11¼ in., diameter 5¾ in., tapering at the bottom to 3¼ in., walls ⅜ in. Owing to the fact that fused silver chloride will pass through a clay crucible almost as rapidly as through a sieve, they are thoroughly soaked in a saturated solution of borax before being used. After this treatment they will withstand the action at a red heat of silver chloride and lead chloride for several hours without undue injury. In operating the process, 500 to 700 oz. of the metal to be refined, together with sufficient borax to form a layer ¾ in. deep on the fused metals, are melted in the crucible, which stands in a plumbago guard-pot to catch any leakage due to a defective crucible or an accident. The clay crucible is covered with a clay lid having a slot for the passage of the clay pipe-stem. These stems are made of white clay and are 25 in. long, ½ in. diameter, ⅛ in. bore, and connect with the end of the lead supply pipe by a flexible rubber joint. When the metal and borax are melted, the pipe stem, previously heated to redness, is introduced through the slot in the lid, pushed to the bottom of the crucible and held in position by a clamp. The chlorine is slowly admitted by cautiously opening the glass stop-cock controlling the supply to that particular furnace, until the gas is passing through the metal with a steady pulsation. As lead and copper are nearly always present, dense fumes of the chlorides of these metals immediately appear, and practically the whole of the chlorine is absorbed. As the action continues, silver chloride is formed and floats on the top of the gold together with some fused copper chloride underneath the layer of borax. During the process all base metals are converted into chlorides and expelled, finally leaving the gold, the fused silver chloride, and the borax cover. The finishing point is judged by the brown stain formed on a piece of cold pipe-stem held in the fumes issuing from the pot. Workmen become very expert in judging the finishing point by the colour of the flame. When it is considered that the chlorination is complete, the pot is withdrawn from the furnace and placed under a hood connected with the flue for a few minutes until the gold is set. The silver chloride and borax are still liquid, and these are poured off into iron moulds placed under a hood connected with the exhaust fan. The moulds are 12 by 12, and 2 in. deep. The pot is now inverted on an iron table, when the cone of fine gold falls out. This is quenched and cleaned, and several are melted together into ingots of convenient size. The average assay of the ingots is 995, and the gold is quite tough. The difference between 995 and 1000 is silver and a little copper. If gold of a higher fineness is required, it is easily produced by the electrolytic process, the chlorinated gold being used for the anodes. By this means the fineness may be raised to 999·7 or 999·9.

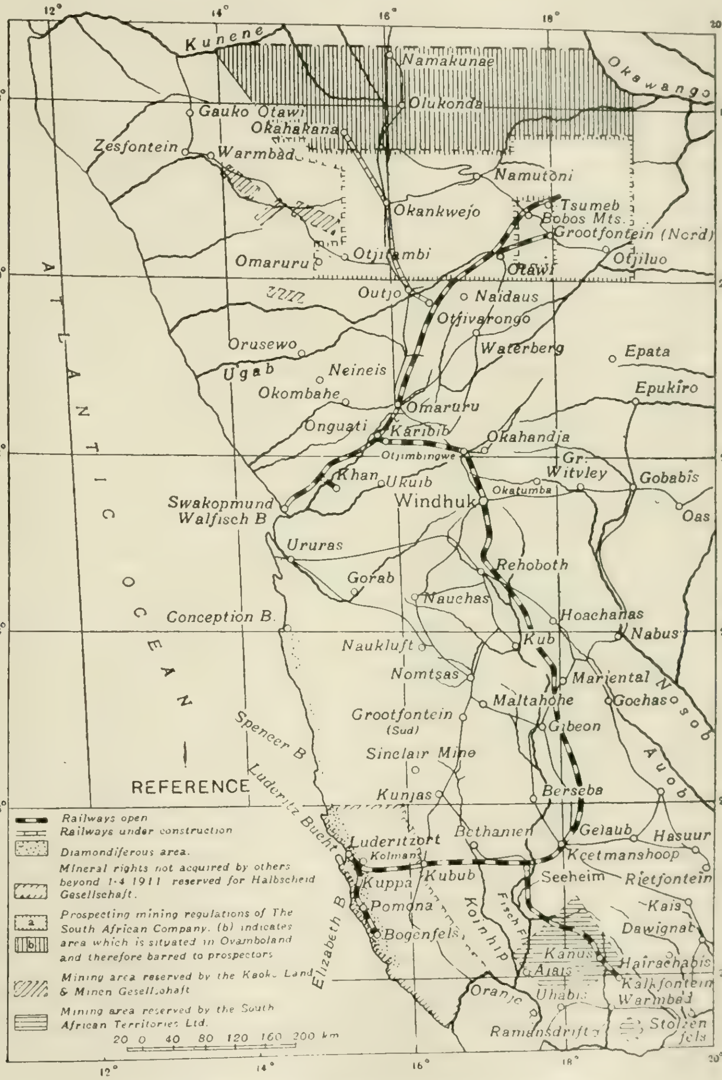
The time required for chlorination is dependent on the amount of metal to be removed; for instance, an ingot weighing 500 oz. and containing 140 oz. base, chiefly lead, and 80 oz. silver, required 7 hours. When a large quantity of silver is present, it is necessary to dip the fused silver chloride out with a small crucible, otherwise it would overflow. The silver chloride contains some gold, which is removed in the following manner. The cakes are broken up and melted in No. 40 plumbago crucibles, and kept at a temperature a little above the melting point of silver, and an amount of sodium carbonate equal to 10% of the weight of chloride is thrown slowly on the surface. This produces a shower of silver globules which collect the particles of gold and sink to the bottom. A second addition is made after a few minutes and the resulting shower of globules allowed to settle. It then stands 5 or 10 minutes, and the pot is withdrawn from the furnace, cooled below the melting point of silver, and the liquid silver chloride poured out. At the bottom of the pot is a large silver button containing all the gold.

The cakes of gold-free silver chloride are broken into pieces approximately ½ in. square, folded in flannel bags so as to form a parcel about 18 in. long, 2 in. thick, and 12 in. wide. Each parcel is placed in a cane basket, and a number are piled on top of each other in a tank full of hot water and kept hot by steam. The tank is divided into two compartments admitting free circulation of the liquid; any copper chloride is in the course of 48 hours dissolved out. As the liquid circulates it comes in contact with scrap iron in the second compartment and is reduced to metallic copper, forming a sludge which settles at the bottom of the tank. When all the copper chloride is removed, the silver chloride is emptied out of the bags, washed by decanting, acidified with hydrochloric acid, and reduced to metallic silver by contact with iron plates. The resulting silver is washed, melted, and cast into ingots, with fineness varying from 995 to 998, and is practically gold-free.

Increasing the Heating Power of Coal.—Some of our readers may remember the series of attractive advertisements in the daily papers and popular magazines during last winter, in which the addition of a small amount of powder to coal was alleged to double its heating power. "Two tons of coal for the price of one" was the text. At the time scientists did not see how such a thing was possible, and by now the unscientific have no doubt arrived at the same conclusion by experience. An excellent service was performed by A. Vernon Harcourt when he read a paper on the subject before the Royal Society of Arts in May. He reported that the article sold by the advertisers consisted of a cardboard box containing half-a-pint of a pink powder. The directions were to stir a heaped teaspoonful of the powder in a pint of water and sprinkle the mixture over the coal contained in three full scuttles. This proportion is equivalent to about 1 grain of powder to the pound of coal. Repeated trials failed to substantiate the advertisers' claims. An analysis was made of the powder, with the following result: Common salt 83·85%, calcium carbonate 8·71%, ferric oxide 2·88%, silica 0·69%, water 3·57%, total 99·7%. As regards its effect in slackening the rate of combustion, any such action would be due to the effect of the pint of water to which the powder was added. Arguing from the fact that the presence of sodium salts near a gas flame will increase its luminosity, Mr. Harcourt thought it worth while to investigate whether the common salt in the powder in any way increased the amount of radiation of heat. He conducted an extensive series of experiments with coal and coke, dry and wetted with the patent solution. He found that the radiant heat emitted by coke was much the same whether the solution was added or not. As regards coal, comparative measurements could not be considered dependable, as during the earlier period of combustion hardly any radiant heat is emitted, and unless the fire is fully coked no exact measurement is possible. Thus it is best to make experiments on radiant heat with coke alone. It will be seen, therefore, that Mr. Harcourt's results point to a possible slackening in the rate of combustion owing to the water added, and to practically no effect in the emission of radiant heat.

German South-West Africa.—The *Bulletin* of the Imperial Institute for July contains an article on the economic resources of German South-West Africa. The territory may be divided, from the geological point of view, into three tracts. The first consists of a narrow coastal strip of sand dunes, extending a few miles inland in the northern part, and from 60 to 80 miles inland in the southern part. As recorded in our June issue, the coastal belt north and south of Lüderitzbucht is diamondiferous. The second consists of a mountainous belt composed of rocks ranging from the Pre-Cambrian to the Permo-Carboniferous. The Pre-Cambrian group of rocks comprises gneiss, schist, crystalline limestone, and intrusive granite, corresponding to the basement complex of other parts of southern Africa. Outcrops of these rocks are found over wide areas in Namaqualand, the southern section of the country, and Damaraland, the central section. The highest mountains are the Great Kamas in Namaqualand, 6500 ft., and Omatako in Damaraland, 9000 ft. Resting unconformably on the Pre-Cambrian rocks is a series of shales, sandstones, dolomites, quartzites, and conglomerates. In Namaqualand the formation is known as the Namaqualand series, and in the northern part, or Ovampoland, as the Otavi series. The formation belongs to early Paleozoic age, presumably Silurian, and may be classed as contemporary with the Transvaal System. The Otavi series is of importance owing to the copper-lead deposits in the dolomites. Lying unconformably on the Namaqualand series, notably in the region of the Fish river, are the Karoo beds belonging to the Permo-Carboniferous. The basal bed is of glacial origin, corresponding to the Dwyka conglomerate. The Karoo beds in other parts of South Africa are usually associated with coal deposits, but so far in German South-West Africa the only record of coal beds is in connection with a boring at Anros near Keetmanshoop, where the indications were none too promising. A noteworthy feature of the Karoo beds are intrusive pipes of peridotite. These are found in the district between Gibeon and Berseba, and on the Lion river, a tributary of the Fish river. The pipes resemble those at Kimberley, but no diamonds have been found in them so far. In the northern section of the country, Ovampoland, a series of rocks lies unconformably on the Otavi series, known as the Kaoko series. These rocks may be taken to be of the same age as the Karoo rocks of Namaqualand. The third tract of the country comprises the Kalahari desert, consisting of sands, with here and there an outcrop of limestone.

The mineral resources of chief importance are the diamond deposits round Lüderitzbucht, and the copper-lead deposits at Otavi in Ovampoland. We gave detailed information of the diamond fields in our June issue, so need not recapitulate here. As regards the copper deposits, the chief mine is at Tsumeb, and other notable occurrences are the Otjisongati, north-east of Windoek, the Khan and Ida mines in the Swakopmund district, and the Sinclair northeast of Lüderitzbucht. At Tsumeb, the orebody occurs in a compact grey dolomite of perhaps Silurian age, and is in the form of a number of steeply-dipping lenses. The ore is complex, containing galena, chalcocite, enargite, and other minerals, the relative lead and copper content varying widely at different parts. The



Sketch Map of German South-West Africa.

other copper deposits of the country are in the Pre-Cambrian rocks. The most important of these is the Otjisongati, where lenses traverse gneiss. The lenses consist of quartz which carries chalcocite, with many oxidation products in the outcrop. The Sinclair mine is of similar character, and deposits also occur in the neighbourhood of Rehoboth. At Gaidip, on the Orange river, east of Ramansdrift, copper ore is found near an intrusion of quartz-diorite. The deposits in Khan valley resemble those at Gaidip. The gangue is quartz, and the copper minerals are chalcopyrite and bornite, associated with pyrite. The Khan mine has been opened for 1300 ft. in length and to a depth of 750 ft. The lode is 6½ ft. wide, and averages 7½% copper. Railway communication has been effected with the Otavi railway, and a concentrating plant was on order before the war began. In various parts of Damaraland, copper minerals are found as impregnations in mica schist, and at the Gorap and Matchless mines this type of ore deposit has been worked.

No gold deposits of importance have as yet been found, though reports of its occurrence in veins have been received from the Rehoboth and Bethanien districts. Massive iron ore has been found at Kalkfeld northwest of the Otavi railway. Auriferous lead-copper ore is reported in the Little Karas mountains and in the Fish river district. Tin has been found in the Erongo mountains northeast of Swakopmund. Vanadium, tungsten, molybdenum, and tantalum minerals have been found, and monazite has been reported in the Fish river district.

CURRENT LITERATURE

[*Copies of the original papers and articles mentioned under this heading can be obtained on application to the Technical Bookshop, Salisbury House, London E.C., the book department of The Mining Magazine.*]

Ferro-Concrete for Mines. — The *Iron & Coal Trades Review* for July 23 describes the ferro-concrete headgear at the Bentley colliery, south Yorkshire.

Making Drill-Bits. — The *Engineer* for July 16 describes the new machine designed by the Sullivan Machinery Co. for making and sharpening drill-bits.

Flotation.—The *Engineering and Mining Journal* for May 29 contains an article by O. C. Ralston and F. Cameron, published by permission of the United States Bureau of Mines, reviewing present progress in flotation.

Flotation.—The *Mining and Scientific Press* for June 26 contains a paper by O. C. Ralston, prepared for the United States Bureau of Mines, describing the various processes proposed in connection with selective flotation.

Flotation of Oxidized Ores.—In the *Engineering and Mining Journal* for June 19, A. Schwarz, of Joplin, Missouri, describes work done by him in treating oxidized ores with sulphuretted hydrogen with the object of coating them with sufficient sulphide to make them amenable to the flotation process. It is claimed that the method can be applied to floating selectively mixed carbonates or oxides. In the issues of May 29 and July 10, O. C. Ralston and F. Cameron comment on the same subject. It would be well if Mr. Schwarz entered into greater detail, and described the results of specific experiments.

Handling Ore.—In the *Mining and Engineering World* for July 3, C. A. Tupper describes the mechanical installations for handling ore at the Calumet & Arizona smelter.

Gold Assay.—In the *Mining and Scientific Press* for June 12, Rowland King describes a method of determining gold in blister copper.

Wood Fuel for Assaying.—The *Monthly Journal* of the Chamber of Mines of Western Australia for May contains a paper by H. R. Edmands describing an assay-furnace constructed for using wood-fuel.

Homestake Metallurgy.—The July *Bulletin* of the American Institute of Mining Engineers contains a paper by Allan J. Clark describing recent modifications in metallurgical practice at the Homestake gold mine, South Dakota, giving an account of variations in practice since the publication of the paper by the author and W. J. Sharwood three years ago by the Institution of Mining and Metallurgy.

Zinc Metallurgy.—The Annual Report for 1914 of the Inspector of Alkali Works contains an account of an investigation as to the prevention of the escape of chloride fumes in the smelting of zinc ashes or waste from galvanizing works.

Spitzbergen Coalfields.—The *Geographical Journal* for July contains a paper by R. N. Rudmose Brown on Spitzbergen geography, mineral resources, and political conditions, based on observations made by the author and W. S. Bruce during the latter's eighth expedition in 1914.

Mount Lassen.—In the *Mining and Scientific Press* for June 19, H. W. Turner writes of the present eruptions at Mount Lassen in connection with the Tertiary eruptions of the Sierra Nevada, California.

The Altai Mining District.—In the *Mining and Scientific Press* for June 26, H. W. Turner describes the geology of the Altai district, Siberia, giving particulars of the properties of the Russian Mining Corporations.

Mesabi Iron Ore. — In the *Engineering and Mining Journal* for July 17, J. F. Wolff commences a series of articles describing the orebodies of the Mesabi region, Minnesota.

NEW BOOKS

Working Data for Irrigation Engineers. By E. A. Moritz. Cloth, octavo, 400 pages, illustrated. New York: John Wiley & Sons. Price 17s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

This book is primarily intended for the use of the civil engineer engaged in transporting and distributing water for irrigation purposes. But water-supply for mines, especially alluvial mines, presents practically the same problems, and the construction of dams and flumes in particular has to be studied. Mr. Moritz's book is not descriptive of the necessary installations, but is composed largely of tables and diagrams which simplify the calculations. The labour bestowed on the collection and collation of the matter contained in this book has been very great, and though we have not space for a detailed review, we have pleasure in recording our appreciation of the author's work.

Rubber-Producing Companies. Compiled by the Mincing Lane Tea and Rubber Share Brokers' Association. Cloth, octavo, 550 pages. London: *The Financial Times*. Price 3s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

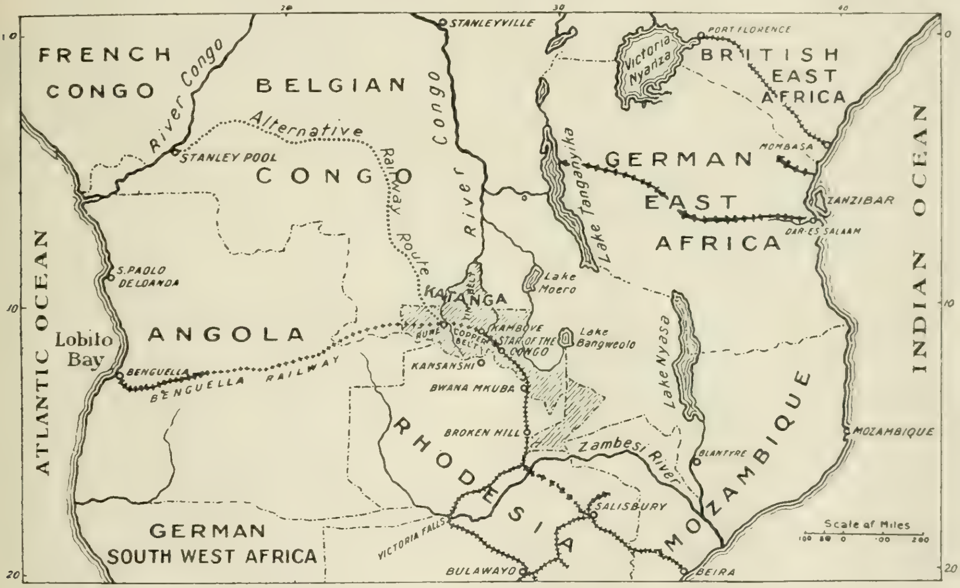
This year-book gives full particulars of all the companies engaged in the production of rubber.

Oil and Petroleum Manual, 1915. By Walter R. Skinner. Cloth, octavo, 250 pages. London: W. R. Skinner. Price 4s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

This is the sixth annual issue of a valuable handbook, which gives full information about the oil and petroleum companies.

COMPANY REPORTS

Tanganyika Concessions. — This company was formed by Robert Williams in 1899 to acquire a concession in Northern Rhodesia. Railways have been built and mines developed by subsidiary companies. Subsequently the company became interested in territory farther north, in the southern part of the Belgian Congo State, this property being held by a Belgian company, the Union Minière du Haut Katanga, the Tanganyika Concessions now owning a 40% interest in the share capital. The company has also financed the construction of the Benguella railway from Katanga to the west coast of Africa. The great enterprise of the Union Minière has been the development of the copper deposits at the Star of the Congo, Kambove, and other mines. Smelting commenced in 1911. The report of the Tanganyika Concessions for the year 1914 states that on the outbreak of war part of the staff of the Union Minière was transferred from Brussels to London in order that smelting operations and the sale of the copper should be continued. The Union Minière is unable to hold a general meeting of shareholders under present circumstances. During the year 1914, the amount of ore smelted was 92,381 tons and 10,722 tons of copper was produced. For the first half of 1915, the production was 6932 tons, increasing from 823 tons in January to 1405 tons in June. Two more furnaces are being built, and when all five are at work in 1916, the yearly output will be at the rate of 25,000 tons. As the Union Minière has not been able to make up its accounts or pay a dividend, the Tanganyika Concessions is short of income and has not been able to pay debenture interest. The sanction of the court has been obtained to postpone payment until after the war. The subsidiary, the Rhodesia-Katanga railway, has made sufficient profit to pay £44,000 as debenture interest and £9000 in addition. The company operating this railway also owns the Kansanshi copper mine in Northern Rhodesia, but this is not being worked at present. The Benguella railway is still under construction, and the 320 miles from the coast at Lobito Bay is being worked at a profit. Another 900 miles remains to be built. At the meeting of shareholders, Robert Williams gave particulars relating to the ore reserves. At the Star, Kambove, and Luushia mines, the developed ore totals 6,026,500 metric tons, of which one-fifth averages 15% copper and the remainder 7%. About one-quarter of the 7% ore can be treated to yield concentrate averaging 18% copper, leaving 4,400,000 tons averaging 6%. This is all above the adits. Drilling below the adit at Kambove indicates the existence of 3,000,000 tons additional. Prospecting and development has been done at other points on the copper belt, and altogether the reserve above water-level is estimated at 40,000,000 tons averaging 8% copper.



Map of Central Africa showing the position of the Katanga copper deposits.

Shamva Mines.—This company was formed in 1910 by the Consolidated Gold Fields and Lewis & Marks groups to develop a large gold deposit on Lone Star Hill, in the Abercorn district of Rhodesia. The Gold Fields Rhodesian Development Co., represented by H. A. Piper and W. F. H. Dudgeon, are the consulting engineers, and C. W. Terry is mine manager. The metallurgical plant, containing 56 Nissen stamps and 10 tube-mills, started in January 1914, and the first dividend was paid in March last. The report for the year 1914 shows that 449,315 tons of ore averaging 3·52 dwt. per ton was treated for a yield of 64,730 oz. of gold, being an extraction of 2·88 dwt. per ton, equal to a recovery of 74·88% of the estimated content. The low average recovery was due to the usual absorption of gold in a new plant. During the latter part of the year the extraction greatly improved, and as the recovery, 99·3%, exceeded the theoretical figure 92·4%, that is the difference between the assays of the feed and tailing, it is clear that some of the absorbed gold was subsequently released. Mr. Dudgeon mentions that some of the locked-up gold was recovered from the tube-mill linings. The ore reserve on December 31 was estimated at 2,044,612 tons averaging 5·24 dwt., as compared with 2,405,796 tons averaging 5·01 dwt. at the end of 1913. Development on the 4th level has been disappointing, as the orebody is much shorter than on the levels above. Two winzes have been sunk from the 4th level, and a 5th level opened. On this level ore has been found, and further sinking is in hand in order to test the ore on a 6th level. The accounts for the year show an income of £274,934 from the sale of gold and a profit of £85,931, out of which £75,000 has been distributed as dividend, being at the rate of 12½%. From July 1 it is intended to distribute 7½% per quarter. The yield per ton was 12s. 3d., and the total cost 8s. 1d., leaving a divisible profit of 4s. 2d. per ton

Eldorado Banket.—This company was formed in 1906 by the Rhodesian Exploration & Development Co. to acquire the Eldorado gold mine, in the Lomagundi district of Rhodesia. Three years ago the control passed to the Consolidated Gold Fields, and H. A. Piper was appointed consulting engineer. Dividends were first paid in 1908, and for five years averaged 30%. Two years ago the position became adverse, partly on account of caving, partly because the parallel lode disappeared with depth, and partly owing to the development on the main lode being unsatisfactory. The report for the year ended March 31 shows that, owing to the depletion of the reserves in the upper levels, it became necessary to reduce the amount of ore treated from 5000 to 4000 tons per month, and when these reserves are exhausted, as they will be before long, a further reduction to 3000 tons will be made. Two years ago the monthly output of ore was 7500 tons. The 14th, 15th, and 16th levels have been fully developed. The lengths of the ore-shoots on the respective levels are 95, 110, and 140 ft., and the average assays are 19·2 dwt. over 6ft. 10in., 13·7 dwt. over 5ft. 10in., and 12·9 dwt. over 6ft. 1in. respectively. An auxiliary shaft is to be sunk below the 16th level in order to obviate long cross-cuts from the main vertical shaft. The reserve on March 31 was estimated at 54,844 tons, averaging 14·2 dwt., as compared with 47,950 tons, averaging 13·7 dwt., on March 31, 1914, and 74,826 tons, averaging 16·4 dwt., on March 31, 1913. Of the reserve, 23,241 tons, averaging 13·3 dwt., is immediately available for stoping, 18,654 tons averaging 9·4 dwt. is broken ore in the stopes and bins, and 12,949 tons, averaging 22·9 dwt., is in pillars. During the year 57,074 tons was raised and treated for a yield of gold worth £132,393, and the profit was £57,597, out of which £2250 was paid to the directors as their share of the profits, and £52,500 was distributed as dividend, being at the rate of 17½%. As regards the future, all depends on the developments below the 16th level.

Wanderer (Selukwe) Gold Mines.—This company was formed in 1899 to acquire the Wanderer, Ashton, and other gold mines, in the banded ironstones of the Selukwe district of Rhodesia. Edmund Davis is chairman, Noel Griffin is consulting engineer, and Stanley Fletcher is manager. The ore is of low grade, averaging 2½ to 3 dwt. per ton, and as the orebodies are wide and the ore soft and readily amenable to cyanide treatment the cost is low. But no dividend has been paid until this month, though £60,000 was paid to shareholders as a reduction of capital in April last. The report for the year ended April 30 shows that 135,958 tons of ore was raised, of which 71,099 tons came from the Wanderer South, 33,245 tons from the Wanderer North, 13,622 tons from the Kemerton, and 17,992 tons from the Ashton. The average content of the ore was 2·96 dwt., and the extraction 2·36 dwt. The yield of gold was 16,991 oz., realizing £70,751, or 10s. 5d. per ton milled. The company's profit was £15,115, out of which £15,000 has been distributed as dividend, being at the rate of 16⅔% on the reduced capital. The balance, £21,650, brought forward from the previous year, is carried forward. Mr. Fletcher reports that the ore reserves are nearly depleted, and that at none of the properties is there an expectation of any discovery. On April 30 it was estimated that 55,000 tons remained at the Wanderer South, 1000 tons at the Kemerton, and 4000 tons at the Ashton. In spite of much active exploration at the Wanderer, little or no ore has been disclosed, and it is probable that the reserves will be exhausted by November. When the company was formed in 1899 to acquire the property from Mr. Davis's company, the Charterland Goldfields, the capital was £450,000. On reconstruction in 1909 the £1 shares were reduced to 5s., and additional shares issued. In April of this year the denomination of the shares was reduced to 3s., and £60,000 in cash was returned to shareholders.

Transvaal Gold Mining Estates.—This company is in the Central Mining control, and is by far the largest gold producer in the Transvaal outside the Rand. The properties are at or near Pilgrim's Rest, and have been worked since 1895. There are three groups of mines; the largest, called the Central Mines, is at Pilgrim's Rest, and consists of seven separate workings, of which Duke's Hill, Peach Tree, Theta, and Graskop, are the most important; the Elandsdrift mine is 20 miles south, and the Vaalhoek 12 miles north. S. Aimetti is general manager, George Carter is manager at the Central Mines, William Patrick at the Elandsdrift, and Milverton Ford at the Vaalhoek. The report for the year ended March 31 shows that the profits were decreased by a fall in the grade of the ore from the Central Mines. Developments have increased the tonnage of reserve, but the average content is below that of a year ago. During the year under review, 136,419 tons of ore was raised from the Central Mines group, 44,084 tons coming from the Duke's Hill South, 52,366 tons from the Peach Tree and Columbia Hill, 18,654 tons from the Theta, and 21,315 tons from the Graskop. The yield of gold was worth £337,840, or 49s. 6d. per ton. During the previous year, 139,976 tons was treated, for a yield of gold worth £408,407, or 58s. 1d. per ton. At the Elandsdrift, 7985 tons of ore yielded gold worth £41,486, as compared with 8053 tons and £37,442 the previous year, and at Vaalhoek 17,550 tons yielded gold worth £29,170, as compared with 17,860 tons and £28,574. The total revenue was £408,497, and the net profit was £219,369, out of which £19,256 was paid as profits tax, £13,428 applied to the redemption of debentures, and £181,267 distributed as dividend, being at the rate of 30%. The dividend for the previous year was £226,584 or 37½%. The outstanding debentures amount to £77,992. The debenture issue was made in 1910 to provide a hydro-electric station on the Blyde river, a short distance to the north of Pilgrim's Rest. The reserve at the Central Mines group on March 31 was estimated at 401,660 tons, averaging 13·3 dwt., as compared with 389,233 tons and 14·4 dwt. a year ago. The reserves at the other two groups have been fully maintained. During the year under review great inconvenience and expense was suffered owing to the excessive rains and consequent floods, as has been recorded in our pages, but the figures for the year show that the output and extraction were well maintained in spite of these adverse conditions.

Central Zinc.—This company was formed in 1906, as a subsidiary of the Sulphide Corporation, for the purpose of erecting a zinc-smelting plant at Seaton Carew, near Hartlepool, Durham, where the zinc concentrate produced at the corporation's mines at Broken Hill was to be treated. The works were started on a small scale, and the number of furnaces has been slowly increased, but the scale of operations attained is far less than was originally contemplated. The report for the year ended March 31 shows that, on the declaration of war, many employees joined the army, and that after the bombardment of Hartlepool on December 16 the German workmen were interned. The output was in consequence gradually decreased, the number of smelting furnaces employed being reduced from six to three. The amount of concentrate roasted was 8274 tons, and the smelting furnaces treated 9045 tons of roasted concentrate and other zinciferous material, for a yield of 3192 tons of spelter, 89 tons of blue powder, 43 tons of metallic lead, and 6262 tons of argentiferous leady residue. The last-named product was treated on concentrating tables, for a yield of 3351 tons of silver-lead concentrate, which was sold to lead smelters. The accounts show a profit of £10,413, of which £3284 goes to the Sulphide Corporation. The corporation contracted to guarantee 5% interest on the share capital of the company, £150,000, for a period of 10 years from the formation of the company, and has paid £51,013 in default of any divisible profit being earned.

Broken Hill Block 14.—On the outbreak of war the mining of sulphide ore was suspended, but the extraction of carbonate ore from the old workings in the upper levels was continued on about the usual scale. During the half-year ended March 31, the amount raised was 4608 tons, averaging 27·2% lead and 15·5 oz. silver, as compared with 5062 tons averaging 25·2% lead and 16·6 oz. silver during the previous half-year. The income from the sale of the ore was £13,088. The loss on the half-year's work was £865, but as £7744 was written back from the account providing for fall in metal prices, it was possible to distribute the interest, £1500, on the £30,000 preference shares, and a dividend of £5000 on the £500,000 ordinary shares. During the half-year attention has been given to filling the sulphide stopes and putting them in better condition.

Broken Hill Block 10.—The report for the half-year ended March 31 shows that no ore has been raised, and the mill has been idle, following the suspension of operations on the outbreak of war. Development was continued until December 19, after which date work was confined to overhauling the machinery and plant. O. B. Ward, the manager, has spent much time at the gold-mining property on Misima island, off the coast of Papua, particulars of which were given in our issue of February last.

Associated Gold Mines of Western Australia.—This company was formed in 1894 to acquire the Australia and other leases at Kalgoorlie. Dividends were paid from 1898 to 1909, totalling 150% on a capital of £500,000. In 1910 the grade of the reserve was found to be lower than estimated, and since then the mine has been a low-grade proposition. Small dividends were paid for the years ended March 31, 1913 and 1914. The report for the year ended March 31 last shows that the yield per ton continues to decrease, gold worth £135,858 being extracted from 127,057 tons, as compared with £152,105 from 127,856 tons the year before, being 21s. 5d. per ton as compared with 23s. 9d. After all expenses were paid and allowances made for depreciation, the year ended with an adverse balance of £8659. D. F. McAulay, the manager, reports that the reserve of broken ore in the stopes amounts to 32,479 tons averaging 19s. 8d. per ton, and that during the three months ended March 31 the yield was only 17s. 11d. per ton. He states that there is a "reasonable expectation of obtaining a limited tonnage of high-grade ore" during current development. The company also has interests in Canada. In November the option on the North Thompson property adjoining the Hollinger mine at Porcupine was exercised, and a subsidiary company formed to work it. Shaft-sinking is in progress, and a depth of 260 ft. attained at the time of the report. Work on the Keeley mine in Lorrain south of Cobalt, in which the company holds an interest, has been greatly curtailed owing to circumstances caused by the war.

Kramat Pulai.—This company was formed in 1907 to acquire alluvial tin property at Pulai, in the Kinta district of Perak, Federated Malay States. The capital is £100,000, and dividends have been paid since 1912. Nutter & Pearse are the managers, and F. W. Payne & Co. are the consulting engineers. Three hydraulic elevators are employed. The report for the year 1914 shows that 231 tons of tin concentrate was won from 465,700 cu. yd., selling for £19,606, as compared with 201 tons, 582,400 cu. yd., and £24,142 during 1913. The reduction in the yardage was due to scanty supply of water during eight months of the year. Part of the property is let to tributers, who recovered 151 tons of uncleaned concentrate. The company's royalty on the tributers' produce was £1497. The net profit for the year was £8199, out of which £7500 has been distributed as dividend.

Ipoh Tin Dredging.—This company was formed in 1913 to acquire a tin-gravel property 6 miles south of Ipoh, in the Kinta valley, Perak, Federated Malay States. Reginald Pawle is on the board, Harry D. Griffiths made a report, and M. T. Nelmes Bluck was consulting engineer at the time of flotation. We gave particulars of the deposit in our issue of October 1913. The report now issued brings the accounts to the end of 1914. Owing to certain large shareholders not having paid their calls on the shares, the company was not able to complete payment for the large bucket-dredge. Before the erection of the dredge could be effected, a mortgage on the whole of the assets of the company was given in favour of the builders of the dredge. Additional capital is required, to replace that lost by the failure of these subscribers to pay their calls. Arrangements have been made with the Borneo Company for financial assistance. Further particulars are given in Review of Mining.

Burma Ruby Mines.—This company was floated in 1889 by the Rothschilds for the purpose of working the alluvial ruby and sapphire mines at Mogok, Burma. We have on several occasions recorded the disappointing nature of this venture. The report for the year ended February 28 shows a loss of £11,780, due to the difficulty of selling this class of precious stone nowadays in any large quantity, the adverse situation being naturally accentuated at present by the European war. During this period, 1,149,777 loads of earth was washed at a cost of 7·8d. per load, the amount being much the same as during the previous year and the cost 1·2d. lower. The yield of stones was valued at £38,000. The original properties at Mogok are not giving good returns nowadays, but the Kathe mine, 8 miles away, acquired recently, is giving satisfactory results and promises to be highly productive. The Indian Government is allowing the payment of certain sums owing as royalty to stand over until after the war.

Ropp Tin.—This company is in the control of Edmund Davis and the Consolidated Gold Fields of South Africa. It was formed in 1911 to acquire alluvial tin properties south of Bukuru, Northern Nigeria. So far, the concentrate has been won by calabashing, but plans are in hand for the erection of two dredges, as the drilling conducted by W. E. Thorne has proved large tracts of dredgable ground. The capital was originally £30,000, and in 1914 £75,000 additional cash was provided by the issue of 75,000 shares of 4s. nominal value at £1 each. Early in 1914 further funds were required, and £50,000 debentures were created, of which £30,000 were issued. The Treasury did not permit the issue of the remaining £20,000, so the money has been obtained privately by loan. The report for 1914 shows that 369 tons of tin concentrate was recovered and 241 tons shipped. During the year, the sale of concentrate, the amount not specified, brought an income of £30,770, and the net profit was £9351. Adding £9028 brought forward from the previous year, there was an available balance of £18,380, out of which £11,250 has been distributed as dividend, being at the rate of 25% on the nominal capital of the company. The reserve of proved ground is estimated at 5,974,865 cubic yards containing 11,472 tons of 70% concentrate. The two dredges on order are to have buckets of 2¾ cu. ft. capacity. J. Fordyce Balfour is superintending engineer, and J. Daniel manager.

San Miguel Copper Mines.—This company was formed in 1904 to acquire a pyrite property in the south of Spain. The directorate was reorganized in 1907, and the control is in the same hands as the Pena. The company has not been successful financially. At first, dividends were paid quarterly, but it was soon found that their distribution had not been warranted. In 1912 and 1913 small dividends were paid. The report for the year 1914 shows that the output suffered restriction owing to the war, 51,206 tons of ore being extracted as compared with 75,265 tons the year before. Of the output, 40,923 tons was sent to the leaching heaps and 10,283 tons delivered for export. The yield of precipitate was equal to 559 tons of fine copper, and there was also delivered for export 46,772 tons of washed sulphur ore. The accounts show a profit of £9257 on the year's work. Owing to mining by open-cut coming to an end earlier than expected, the suspense account for the removal of overburden has had to be virtually closed, and £24,000 has had to be written off, so it is impossible to declare a dividend. The profit and loss account has been rectified by transference to it of £25,000 from the reserve fund.

Hampden Cloncurry Copper Mines.—This company was formed in Melbourne in 1906 by the Baillieu group to acquire the Hampden and Duchess copper properties in the Cloncurry district of North Queensland. More recently the Trekelano, Pindora, MacGregor, and other properties, have been purchased. As recorded in previous issues, smelting operations were suspended on the outbreak of war, and alternative methods were sought for disposing of the blister copper hitherto sold to German buyers. By the financial aid of the Commonwealth Bank of Australia, it was made possible to resume smelting in the middle of September. The report now issued covers the half-year ended February 28. During this period 11,102 tons of ore averaging 7·4% copper was raised from the Hampden mine, 14,953 tons averaging 11·5% from the Duchess, and 42 tons averaging 12% from the Trekelano. At the smelter, 37,787 tons of ore was treated, 13,652 tons coming from the Hampden, 16,289 tons from the Duchess, 42 tons from the Trekelano, 268 tons from the Answer, and 223 tons from the Mascotte, while 1307 tons was custom ore, and 6006 tons was fluxing ore from the Salmon mine. The product was 3057 tons of blister copper, containing 3025 tons of copper, 915 oz. gold, and 26,779 oz. silver. The ore reserve is estimated at 32,000 tons averaging 7½% copper at the Hampden, 54,000 tons averaging 14% copper at the Duchess, 77,000 tons averaging 7% copper at the MacGregor, 13,000 tons averaging 10% at the Wallaroo, 35,000 tons averaging 5% at the Pindora, 20,500 tons averaging 11% at the Trekelano, 6000 tons averaging 9% at the Answer, and 2500 tons averaging 16% at the Mascotte. The accounts show an income of £171,136 and a profit of £44,609, out of which £8305 has been written off for depreciation. Since the close of the half-year, £20,000 debentures have been redeemed.

Wheal Kitty & Penhalls.—This company was formed in 1906, under the auspices of J. H. Collins, to work tin mines at St. Agnes, Cornwall. The report for the half-year ended June 30 shows that 10,190 tons of ore was treated for a yield of 107¾ tons of concentrate, as compared with 9670 tons of ore and 155½ tons of concentrate during the previous half-year. The yield per ton was 23·7 lb. as compared with 33·3 lb. The quality of the ore mined in the Wheal Vottle section was well maintained, but in Sara's section the grade has fallen. The income was £10,459, or £97. 1s. 4d per ton, as compared with £12,798, or £82. 6s. per ton. The working cost was £12,226, as compared with £12,425. Some of the old Cornish stamps are worn-out, and the rest of them are in poor condition. Twenty modern California stamps have been purchased and are awaiting erection. The cost of erecting this plant was to be provided out of revenue, but, owing to the present depressed conditions it has been deemed advisable to subscribe funds for the purpose, and debentures to the amount of £2000, bearing 7½% interest, are to be issued. Operations at the mine have been greatly hampered by the absence of the best men, who have joined the army, and it has been necessary to curtail development, the figures for the half-year being 1097 ft. as compared with 1459 ft. during the previous six months. The issued capital of the company is £27,242 in ordinary shares, and £6982 in 10% preference shares. The ordinary shares received dividends of 7½%, 7½%, 5%, and 2½% in 1908, 1909, 1910, and 1911. The preference shares, created in 1910, received 10% in 1911, 5% in 1912, 10% in 1913, and 5% in 1914.

Arizona Copper.—The interim report for the half-year ended March 31 shows that the output was 8774 short tons of copper as compared with 9909 tons during the previous six months. The decrease is owing to the necessity of curtailing operations during the early months of the war. Of the half-year's output, over 5000 tons was produced during the months January to March 1915. The average price obtained was £55. 4s. 8d. per short ton. The profit was £163,047, out of which £40,761 has been set aside for the redemption of debentures, £12,265 paid as preference dividend, and £75,994 as dividend on the ordinary shares, being at the rate of 1s. per 5s. share. Extensions are being made to the concentrating plant, and the flotation process is to be adopted. Owing to the relatively higher price of electrolyte copper, part of the product is now being refined in this way instead of all of it being sold as standard copper as formerly.

The Mining Magazine

Scientia non habet inimicum nisi ignorantem.

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QUOTATIONS

of leading mining shares on the London Market.
Shares are £1 par value except where otherwise noted.
Quotations are given in shillings.

GOLD, SILVER, DIAMONDS:	July 1 1914	Aug. 3 1915	Sept. 1 1915
RAND:			
Bantjes	14	9	6
Brakpan	51	60	59
Central Mining (£12)	160	125	130
Cinderella	6	3	3
City & Suburban (£4)	52	42	42
City Deep	66	62	61
Consolidated Gold Fields	43	25	24
Consolidated Langlaagte	35	37	38
Consolidated Main Reef	18	19	20
Crown Mines (10s.)	120	85	77
D. Roodepoort Deep	17	16	15
East Rand Proprietary	33	26	22
Ferreira Deep	47	41	42
Geduld	23	29	32
Geldenhuis Deep	26	21	20
Gov't Gold Mining Areas	23	22	23
Heriot	55	56	55
Jupiter	5	6	5
Kleinfontein	24	23	22
Knight Central	8	7	7
Knight's Deep	35	27	25
Langlaagte Estates	20	19	17
Luipaard's Vlei	10	7	6
Main Reef West	7	6	6
Meyer & Charlton	115	110	101
Modderfontein B	89	105	106
Modder Deep	58	84	99
Modderfontein, New (£4)	263	294	230
Nourse	27	23	21
Rand Mines (5s.)	120	89	82
Randfontein Central	17	11	11
Robinson (£5)	57	35	28
Robinson Deep	33	22	22
Rose Deep	43	35	34
Simmer & Jack	12	10	8
Simmer Deep	1	1	1
Springs	11	22	26
Van Ryn	67	55	52
Van Ryn Deep	47	51	50
Village Deep	40	37	36
Village Main Reef	40	29	26
Witwatersrand (Knight's)	71	61	60
Witwatersrand Deep	48	32	30
Wolhuter	14	11	12
RHODESIA:			
Cam & Motor	19	11	12
Chartered	17	10	10
Eileen Alannah	11	6	6
Eldorado	18	10	9
Enterprise	9	5	4
Falcon	14	7	7
Giant	14	5	5
Globe & Phœnix (5s.)	32	26	27
Lonely Reef	27	21	20
Shamva	46	34	36
Wanderer (5s.)	3	1	1
Willoughby's (10s.)	7	5	4
OTHERS IN SOUTH AFRICA:			
De Beers Deferred (£2 10s.)	330	197	212
Glynn's Lydenburg	11	10	11
Jagersfontein	78	52	52
Premier Diamond Defer'd (2s. 6d.)	152	85	85
Sheba (5s.)	4	3	3
Transvaal Gold Mining Estates	37	33	34
WEST AFRICA:			
Abbontiakoon (10s.)	8	8	8
Abosso	14	7	8
Ashanti (4s.)	16	16	16
Broomassie (10s.)	2	½	½
Prestea Block A	15	10	9
Taquah	15	14	14
WEST AUSTRALIA:			
Associated Gold Mines	7	4	4
Associated Northern Blocks	7	4	4
Bullfinch	6	6	6
Golden Horse-Shoe (£5)	43	45	41
Great Boulder Proprietary (2s.)	14	14	15
Great Boulder Perseverance	2	1	1
Great Fingall	9	3	2
Ivanhoe (£5)	50	44	43
Kalgurli	36	31	30
Sons of Gwalia	23	16	17
Yuanmi	3	2	2

GOLD, SILVER, *cont.*	July 1 1914	Aug. 3 1915	Sept. 1 1915
OTHERS IN AUSTRALASIA:			
Blackwater	16	15	15
Consolidated Gold Fields of N.Z.	13	11	11
Mount Boppy	10	10	7
Mount Morgan	52	44	41
Progress	10	5	5
Talisman	33	21	21
Waihi	42	37	35
Waihi Grand Junction	25	21	21
AMERICA:			
Alaska Treadwell (£5)	162	140	136
Buena Tierra	15	8	10
Butters Salvador	20	15	15
Camp Bird	9	4	5
Canadian Mining	—	8	8
Casey Cobalt	13	6	6
El Oro	14	7	7
Esperanza	15	8	7
Kirkland Lake Proprietary	74	27	27
Mexico Mines of El Oro	97	67	70
Oroville Dredging	10	15	14
St. John del Rey	15	14	15
Santa Gertrudis	11	7	7
Tomboy	22	20	20
Tough-Oakes	28	6	6
RUSSIA:			
Lena Goldfields	43	32	30
Orsk Priority	7	9	9
INDIA:			
Champion Reef (2s. 6d.)	11	10	11
Mysore (10s.)	93	76	79
Nundydroog (10s.)	27	25	25
Ooregum (10s.)	23	25	22
COPPER:			
Anaconda (£5)	126	149	155
Cape Copper (£2)	60	50	55
Chillagoe (10s.)	1	½	½
Cordoba (5s.)	6	3	2
Great Cobar (£5)	3	1	2
Great Fitzroy (5s.)	½	¼	¼
Hampden Cloncurry	27	30	27
Kyshtim	55	35	36
Messina (5s.)	15	14	14
Mount Elliott (£5)	55	60	57
Mount Lyell	23	23	21
Rio Tinto (£5)	1355	1100	1100
Sissert	25	19	20
South American Copper (2s.)	22	11	12
Spassky	52	40	39
Tanalyk	78	35	37
Tanganyika	40	24	24
LEAD-ZINC:			
BROKEN HILL:			
Amalgamated Zinc	28	24	22
British Broken Hill	36	22	19
Broken Hill Proprietary (8s.)	36	44	42
Broken Hill Block 10 (£10)	32	21	20
Broken Hill North	52	39	36
Broken Hill South	175	137	120
Sulphide Corporation (15s.)	26	17	17
Zinc Corporation (10s.)	19	12	11
ASIA:			
Burma Corporation	28	34	33
Irtysh Corporation	—	30	32
Russian Mining	31	14	16
Russo-Asiatic	151	75	80
TIN:			
NIGERIA:			
Bisichi	8	5	5
Jos (5s.)	5	4	4
Kaduna (5s.)	15	15	15
Naraguta	17	12	12
N. Nigeria Bauchi (10s.)	3	2	2
Rayfield	5	3	3
Ropp (4s.)	100	12*	14*
OTHER COUNTRIES:			
Aramayo Francke	31	27	26
Briseis	5	4	4
Cornwall Tailings	17	15	12
Dolcoath	11	6	6
Geevor (10s.)	5	2	1
Gopeng	27	26	26
Mawchi	20	6	4
Pahang Consolidated (5s.)	7	6	6
Renong Dredging	36	20	20
Tekka	55	60	55
Tronoh	26	27	31

* Denomination of shares recently changed from £1 to 4s.

METAL MARKETS

COPPER.—The market fluctuated greatly during August. There has been no sustained or important buying, and the course of prices has closely followed the fluctuations of the New York Stock Exchange. Standard has moved between £75. 10s. and £66, standing at the end of August at £69. Munition makers in this country appear to be fully bought for this year's delivery, but in America the demand for war purposes is still active. France has been a steady purchaser. Russian orders have quietened, business there being handicapped by the adverse exchange, and doubtless considerably affected by the course of the war. The margin between standard and electrolytic is over £16 per ton. This would provide a handsome return to refiners in this country if they were not already so busy as to be unable to take advantage of it. American producers are reported to be well sold, and are consequently holding for full prices, while second hands are taking the orders going. The latter have sold as low as 15¾ cents. The latest New York quotation at the end of the month is 18 cents. The increase in output of American mines dissipates any fears of a runaway market.

Average prices of cash standard copper: August 1915, £68. 15s. 1d.; July 1915, £76. 1s. 11d.: August 1914, £56. 10s.

LEAD.—Under the influence of a lower American quotation prices fell in the early part of the month to £20. 5s. Consumers held off in the declining market, and it looked for a time as if a home would have to be found in warehouse for the considerable tonnage reaching here. Since then London arrivals have fallen off, and a rapid and unexpected rise has taken place in the American price. This is attributed to the demand for munitions. Consumers have come in on the rise, but the buying is confined to early requirements, with a consequent heavy premium for spot metal. Russian demand is plentiful, but the actual business placed is not large, difficulties of shipment and of exchange being formidable.

Average prices of soft foreign lead: August 1915, £21. 18s. 11d.; July 1915, £24. 12s. 3d.; August 1914, £20. 9s. 9d.

TIN.—The market has been quiet, not to say dull, with fluctuations within narrow limits. Prices are low, and there is a good deal of pessimism in the minds of dealers. Consumption in this country is checked by the difficulties of export and of fuel supply. In America, however, consumption is on a large scale, and most of the buying is done in the East. Banca tin is being withheld from the market, but dealers see in this only the menace when stocks come to be realized. Straits smelters are also accumulating stocks, which means that September shipments will probably be small, to be made up by large shipments later. The Straits Trading Company's smelter at Singapore is to be closed for repairs during the second half of September, and the shipments are expected to be brought down from 6500 tons to 5000 tons. Business with our Allies is only moderate, the high exchange acting as a deterrent. Speculation is dormant. To awaken it a more cheerful and more settled situation is required. At present the market is controlled by American buying. August closed £154. 10s. cash, and £156 three months, with little immediate indication of the future course of prices.

Average prices of cash standard tin: August 1915, £151. 12s. 10d.; July 1915, £167. 5s. 11d.; August 1914, no quotation.

SPELTER.—Last month's fall in prices continued through August until the official quotation was marked down to £60 to £50. Since then, under the influence of speculative interest, prices have risen again to £74 to £70. Consumers have shown considerable interest, for of course the basis on which they have sold leaves them a good profit. The improvement must be viewed with caution. The famine stage appears to have passed. The output in America has been considerably increased, and demand is unlikely to grow. The inquiry for high-grade qualities for Italy and Russia is active. Our own needs are in the control of the munitions authority.

Average prices of good ordinary brands: August 1915, £67. 15s. 9d.; July 1915, £97. 5s.; August 1914, £29.

ANTIMONY.—The antimony market is practically non-existent, and quotations relating to price are apt to be misleading. Last month we quoted £115 to £125, and these figures will do well enough as an indication of the present position. It is interesting to note that South African houses are turning their attention to the mines in the Murchison Range, where the gold-bearing antimonial ores have been worked hitherto for the precious metal content.

QUICKSILVER.—The present quotation for Spanish quicksilver is £16. 5s. per flask of 75 lb.

PLATINUM.—185s. per oz., nominal.

BISMUTH.—10s. per lb.

COBALT.—8s. per lb.

CADMIUM.—7s. 6d. per lb.

MOLYBDENUM.—The market for molybdenite continues quiet, and the quotation continues at 115s. to 120s. per unit for material containing not less than 90% MoS_2. Ferro-molybdenum containing 65 to 85% molybdenum, 18s. per lb.

IRON.—The market for pig iron has remained quiet during the month. Middlesbrough No. 3 is slightly down at 65s. 6d. per ton. Cumberland hematite remains steady at 95s. per ton. Steel rails, £9. 5s. per ton. Ship plates, £10 per ton. Spanish ore, delivered, 25s. per ton. Cumberland hematite ore, 18s. 6d. to 36s. at mines.

TUNGSTEN.—The Government has fixed a maximum price of 55s. per unit of WO_3 for wolfram and scheelite, and has requisitioned all British supplies. Ferro-tungsten containing 80 to 90% tungsten and low in carbon is quoted at 6s. 6d. to 7s. per lb. Tungsten metal 96 to 98%, 8s. 6d. per lb

ALUMINIUM.—The price still continues to advance, and the latest quotation is £190 per ton, an increase of £20 during the month.

NICKEL.—No alteration in the quotation has been made, and the price stands at £225 per ton.

CHROMIUM.—The quotations for chrome ore remain as given in our report last month: 105s. to 115s. per ton on the basis of 47 to 55% chromic acid. Ferro-chrome, 4 to 10% carbon, £25 to £28 per ton; 2% carbon, £80 per ton.

MANGANESE.—The market continues to be greatly restricted. The ore shipped from India comes almost entirely to this country or France, and the former large deliveries to the United States have ceased. Nominal prices for 50% Indian ore are 20d. to 22d. per unit.

SILVER.—The silver market has substantially improved during the past month, owing to large purchases in various directions. The United States Government has bought freely, and the Indian demand has increased. The quotation is now 23¾d. per standard ounce, a rise for the month of 1d. per ounce.

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,998	363,826	8,794,824	37,358,040
July, 1914	703,136	29,349	732,485	3,111,398
August	684,607	27,311	711,918	3,024,037
September	677,063	25,107	702,170	2,982,630
October	703,985	29,761	733,746	3,116,754
November	685,450	30,386	715,836	3,040,677
December	669,075	26,062	695,137	2,952,755
Year 1914	8,033,567	344,570	8,378,139	35,588,075
January 1915	689,817	25,167	714,984	3,037,058
February	653,213	23,008	676,221	2,872,406
March	727,167	26,768	753,935	3 202,514
April	717,225	26,855	744,080	3,160,651
May	737,752	25,796	763,548	3,243,347
June	727,924	27,356	755,280	3,208,224
July	742,510	27,845	770,355	3,272,258
August	749,572	29,191	778,763	3,307,975

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
July 31, 1914	167,006	9,257	13,656	189,919
August 31	168,851	9,485	—	178,316
September 30	169,619	9,389	—	179,008
October 31	170,438	9,212	—	179,650
November 30	166,039	8,990	—	175,029
December 31	164,650	8,704	—	173,354
January 31, 1915	172,331	8,675	—	181,006
February 28	180,422	8,494	—	188,916
March 31	185,239	8,216	—	193,455
April 30	186,941	8,418	—	195,359
May 31	183,961	8,857	—	192,818
June 30	184,155	9,019	—	193,174
July 31	190,026	9,371	—	199,397
August 31	196,866	9,943	—	206,809

Cost and Profit on the Rand.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Year 1912	25,486,361	29 2	19 3	9 11	12,678,095
Year 1913	25,628,432	27 9	17 11	9 6	12,189,105
January 1914	1,902,733	27 4	18 2	9 3	876,577
February	1,861,442	26 10	17 11	8 10	823,654
March	2,094,098	26 4	17 3	9 1	945,000
April	2,075,561	26 6	17 3	9 3	955.600
May	2,196,287	26 3	17 0	9 3	1,011,968
June	2,178,161	25 5	17 1	9 5	1,025,629
July	2,281,717	25 10	16 9	9 1	1,032,562
August	2,261,800	25 5	16 8	8 9	988,567
September	2,188,939	25 11	16 9	9 1	989,859
October	2,301,795	25 8	16 8	8 9	1,004,264
November	2,192,365	26 3	17 0	9 0	982,346
December	2,167,056	25 11	17 3	8 6	917,662
Year 1914	25,701,954	26 6	17 1	9 0	11,553,697
January 1915	2,237,748	25 10	17 5	8 3	920,194
February	2,077,792	26 4	17 11	8 4	867,782
March	2,366,392	25 9	17 4	8 4	985,511
April	2,289,002	26 4	17 5	8 9	996,846
May	2,416,966	25 8	17 0	8 6	1,031,220
June	2,346,493	26 1	17 2	8 8	1,017,908

The above are the official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 70% of the working profit.

Production of Gold in West Africa.

Year 1912	Year 1913	Year 1914	July 1915	Year 1915
£1,497,179	£1,634,700	£1,727,044	£140,290	£1,009,133

Production of Gold in Rhodesia.

Year 1912	Year 1913	Year 1914	July 1915	Year 1915
£2,707,368	£2,903,267	£3,530,207	£336,565	£2,173,085

Gold Output of India.

Year 1912	Year 1913	Year 1914	Aug. 1915	Year 1915
£2,265,094	£2,299,315	£2,340,259	£197,984	£1,577,680

Production of Gold in Western Australia.

	Export oz.	Mint oz.	Total oz.	Total value £
Total, 1913	86,255	1,227,888	1,314,143	5,582,140
July, 1914	8,294	88,305	96,599	410,324
August	101	102,346	102,447	435,164
September	1,535	103,577	105,112	446,485
October	2,028	99,366	101,394	430,692
November	1,217	109,282	110,499	469,387
December	1,214	101,534	102,748	476,253
Total, 1914	51,454	1,181,520	1,232,974	5,237,308
January 1915	561	98,196	98,757	419,495
February	607	103,661	104,258	442,900
March	1,829	91,872	93,764	398,282
April	1,017	101,592	102 609	435,853
May	2,311	101,359	103,670	440,360
June	1,273	100,036	101,309	430,333
July	555	98,859	99,414	422,271
August	1,079	99,941	101,020	429,103

Other Australian Gold Production.

	1913	1914	Aug. 1915	1915
	£	£	£	£
Victoria	1,847,400	1,740,300	80,300	916,500
Queensland	1,118,610	1,011,310	93,050	728,340

Exports of Copper from United States
(Reported by United States Customs).

Month	Long Tons	Month	Long Tons
July, 1914	34,145	Feb'ry, 1915	12,066
August	19,676	March	29,725
September	23,866	April	20,481
October	28,995	May	25,785
November	20,170	June	15,751
December	16,830	July	16,812
January, 1915	28,197	August	16,289

Nigerian Tin Production.
In tons of concentrate of unspecified content.

Year 1912 tons	Year 1913 tons	Year 1914 tons	July 1915 tons	Year 1915 tons
2,532	5,032	4,832	455	2,850

Production of Tin in Federated Malay States.
Estimated at 70% of concentrate shipped to smelters.

1911 tons	1912 tons	1913 tons	1914 tons	July 1915 tons	1915 tons
43,967	48,250	50,128	49,042	3,544	26,862

Sale of Tin Concentrate at Redruth Ticketings.

	Tons	Value	Average
Year 1911	6151¼	£702,599	£114 4 5
Year 1912	6492	£831,908	£128 5 6
Year 1913	6186	£744,268	£120 2 6
Year 1914	4987	£432,437	£86 14 3
January to June 1915	2826	£261,958	£92 13 10
July 5	202	£18,721	£92 13 5
July 19	204½	£18,102	£88 10 5
August 3	177	£15,069	£85 2 9
August 16	171	£14,098	£82 9 0
August 30	156	£12,935	£82 18 5

Imports of Tin Concentrate into United Kingdom.

	August		Year 1915	
	Tons	Value	Tons	Value
		£		£
Bolivia	1,603	127,004	25,356	2,138,650
Other Countries	401	33,953	6,248	578,685
Total	2,004	160,957	31,604	2,717,335

REVIEW OF MINING

Introductory.—Organization is the keynote of the month. The world has settled down to a belief in a long war, and everywhere arrangements are being made on that basis. Even the Kaiser has repudiated the interview in which he was credited with a promise that the war should end in October. The first wild rush to get men and materials to the front has been succeeded by a better considered effort to provide also for the continuance of the peaceful industries which give sustaining power to a nation. As we note elsewhere, the Ministry of Munitions is taking care that the real productive power of the nation is not seriously impaired by the necessity to turn out shells. The shops of the United Kingdom can make shells and rock-drills too, and both are needed. The same spirit is shown in the attitude taken toward the problem of American exchange. Last autumn, exchange was heavily against New York; now it is against London. The peak in both instances represents temporary conditions. The normal relation of debtor to creditor has not been reversed, nor is it likely to be soon. Heavy buying abroad necessitates credits abroad, as the credits must be granted or the buying will cease, to the damage of the selling country. Just how to arrange this, not for a few weeks but for a year or more if need be, is now being considered by an international committee, and it is this planning for years rather than days that indicates the new spirit abroad. The Russian troops have been driven back, but Russia shows no spirit of surrender. The French are better armed and equipped, and are more determined than ever. Wherever we look we see, not more will to win than has been shown before, but a vastly better understanding of the sacrifices necessary and of the methods to be employed.

Metal prices have receded to a level profitable but not prohibitive, as productive capacity has been increased in the allied and neutral countries. Buyers have realized that it is not necessary to cover at once their requirements for the year, to their own great benefit. The American spelter production has increased enormously, the Japanese output is expanding, distinct progress is being made in solution of the legal and technical difficulties surrounding the Australian zinc concentrates, and it is always possible that the belligerent Governments may arrange for turning loose stocks of spelter that presumably have been accumulating in Belgium. It is to be remembered that Germany has a surplus, and recognizes by now that keeping the Belgians busy makes their own task of policing the country easier.

Transvaal. — The output of gold on the Rand during August was 749,572 oz., and in the outside districts 29,191, being a total of 778,763 oz., worth £3,307,975 as compared with 770,355 oz. worth £3,272,258 in July. The number of natives employed on the gold-mines on August 31 was 196,866, as compared with 190,026 at the end of July, and 168,851 a year ago.

Before the outbreak of war, the directors of the New Modderfontein had decided to extend the metallurgical plant so as to increase the monthly output from 50,000 to 90,000 tons, but the realization of the project had necessarily to be postponed. The board now announces that orders for the additional machinery have been given. The new mill will be erected at the circular shaft that taps the deep levels. The company has an ore reserve of six million tons, and recent developments have been excellent. The report for the quarter ended June 30 shows that 2669 ft. driven on the reef averaged about 2½ oz. over a width of 10 inches.

Debenture-holders in the Main Reef West company are being asked to consent to a postponement of the repayment of debentures, in order that funds shall be available for sinking and equipping two new auxiliary inclined shafts, which are required for the better development of the deep levels. The debentures were created in 1909, and the annual redemption commenced in 1913. It is now proposed to postpone the next payment for three years, and thus supply the company with £75,000 additional working capital.

The West Rand Consolidated Mines has purchased 113 claims from the liquidators of the Lancaster West. These claims adjoin the eastern end of the property, and can be worked from the existing shafts and levels. The claims were estimated by the Lancaster West engineers to contain 150,000 tons of developed ore. The directors of the West Rand Consolidated contemplate additions to the plant in order to increase the monthly output to 45,000 tons.

For several years the development of Booysens, a second deep in the central part of the Rand between Village Deep and Crown Mines, has been planned, but owing to the difficulty of agreeing as to its value as a property in relation to the value of the Robinson Deep, active work has been postponed. Both the Robinson Deep and Booysens belong to the Consolidated Gold Fields group, and they are surrounded by mines of the Central Mining-Rand Mines group. The recent developments of the adjoining Village Deep have been remarkably good, in fact that mine contains large reserves of comparatively high-grade ore in its lowest levels. This fact lends considerable speculative encouragement to Booysens. It is pleasant to record therefore that terms between Robinson Deep and Booysens have been settled, and that the former company will be expanded in order to absorb the latter. The terms are rather complicated and need not be reviewed here, but we may mention that additional capital if necessary has been promised by the Gold Fields and Central Mining companies.

Production commenced in May at the Mutue Fides tin mine, in the Waterberg district of the Transvaal, belonging to the Transvaal Consolidated Land & Exploration Co., which also controls the Groenfontein tin mine. The capacity of the plant is such that a yield of 30 to 40 tons of concentrate per month is expected. Rolls are used instead of stamps, so that the scarcity of water at certain times of the year in this district should not interfere with operations to so great an extent.

The search for antimony has revived interest in the gold-antimony ores in the Murchison Range, northeastern Transvaal. Attempts to mine the deposits of this mineral region have continued spasmodically for many decades. In our issue of October 1912, Alexander O. Brown gave particulars of mining operations past and present. With regard to current interest in the district, many South African houses are undertaking development work, and the Rand metallurgists are keenly investigating methods and processes.

Rhodesia. — The output of gold during July was worth £336,565, which is not far short of the record, £337,241, in October last. Eileen Alannah, Antelope, Golden Kopje, Lonely Reef, and Matabele Queen's showed advances on June.

The ore sent to the mill at the Golden Kopje mine has given a much lower yield than was indicated by the mine samples. Since the commencement of milling in July 1914, until the end of March of this year the yield was 17s. 2d. per ton from ore calculated to average 7·6 dwt. per ton. Much of the difference is of course accounted for by gold absorbed in new plant, and in addition difficulties arose with the filters; but the chief cause of the low yield is the softness of the ore and country rock, and the mining of much waste with the ore. The deposits are in the banded ironstone of pre-Cambrian age, and the orebodies are lenticular in shape with ill-defined boundaries. In order to make-up for this decrease in the assay-value of the ore fed to the stamps, it was decided to increase the monthly capacity from 10,000 tons to 12,500 tons and so decrease the working cost. The latest monthly report, that for July, shows that 12,020 tons gave gold worth £8743, being only 14s. 6d. per ton, with a working cost of £11,748, or 19s. 6d. per ton, so that the position gives cause for some anxiety.

The Bell Reef mine, like many of its neighbours in the central part of Southern Rhodesia, suffers from the presence of arsenic and antimony in the gold ore. The improved plant started in February of last year, and in spite of metallurgical difficulties the recovery rose gradually to 82%. On the other hand, the cost was increased owing to the slowness of the roasting process. The advice of Mr. W. B. Blyth, of Kalgoorlie, has been sought, and he is now on the spot. The July figures show that £5061 was extracted from 3078 tons of ore, being a yield of 32s. 10d. per ton, while the working cost was £6415, or 41s. 8d. per ton.

West Africa.—The output of gold of the West African mines during July was worth £140,290, as compared with £135,289 for June and £152,923 for July last year. The gradual decline noticeable since March has been checked. Prestea Block A shows a slightly improved yield, as do Abbontiakoon and Broomassie.

Of all the British dependencies probably Nigeria has suffered the most from the effects of the war. This fact, with the fall in the price of tin, and the delays in connection with the new survey, have together hit the tin-mining companies badly. The yearly accounts of the various companies are difficult to complete, and many of the financial reports are greatly delayed. For instance, the Rayfield report for the year ended September 30, 1914, has only just been published. This shows that though 572 tons of tin concentrate was sold, a net loss of £4533 was incurred. In April we gave extracts from Mr. J. M. Iles' report on the tests at the Delimi property. Since then another deposit has been disclosed on this property, and Mr. Iles is optimistic.

Australasia.—The Broken Hill Proprietary's iron and steel business is rapidly progressing, and extensions of plant have already become necessary. Additional coke-ovens are to be built, and two more open-hearth furnaces are to be erected.

During the six months ended June 30, the Broken Hill South mine worked at about three-quarters capacity, the mill treating 130,320 tons of ore for a production of 24,961 tons of lead concentrate. This is an improvement on the results during the previous six months when 112,750 tons yielded 20,375 tons. A net profit of £123,772 was made.

A Broken Hill syndicate headed by Mr. F. C. Howard, chairman of the South company, is interested in the Catamaran coalfield in Tasmania. Extensive boring operations have been conducted, and a three-compartment shaft has been sunk. The seam is estimated to average 11 ft. in thickness, but only the bottom portion, 4 to 7 ft. thick, will be worked. The area tested may be expected to yield 7,000,000 tons of coal.

A large proportion of the shareholders in the Talisman Consolidated are resident in New Zealand, and are anxious to avoid the high English income-tax, which they have to pay in addition to their own taxes. Consequently a proposal is being made to remove the office and responsible management to New Zealand.

The discovery of additional ore at Mount Morgan recently announced will add considerably to the reserve. The orebody is 64 ft. wide, averaging 2⅜% copper and 9⅝ dwt. gold. A sintering plant has been added for the treatment of the fine concentrate, which had previously been briquetted. The working cost has been reduced by about 7s. per ton of Mount Morgan ore, and now stands at 40s. 3d. The yield of copper during the six months ended May 31 was 4481 tons and of gold 58,196 oz., and as the average price for electrolytic copper was £75 as compared with £57 during the previous period, the company's profits substantially increased, admitting of a distribution of £100,000 as dividend.

Operations at the Whim Well copper mine in the north of Western Australia are to be re-started, additional funds having been obtained in London. The company is being reconstructed on the basis of an assessment of 5s. on each of the 225,000 £1 shares. The subscription to 100,000 of these shares has been guaranteed, and the capital thereby received will be sufficient to make it possible to resume shipments. The mine contains large reserves of ore, and it is a pity that substantial sums of capital are not forthcoming wherewith to erect new metallurgical plant.

India.—At the North Anantapur, an ore-shoot has been intersected in the 850 ft., the lowest, level. The shoot is 5 ft. wide and assays 11 dwt. gold per ton. It is presumably the continuation of the shoot that decreased in value below the 750-ft. level. Of the Kolar group, the Mysore has been conspicuous in the share market owing to the fall in the quotation. For the last month or more the quotation has been below £4 for the 10s. share, as compared with £5, a price that had ruled for many months previously. With the increase in depth and the decreasing proportion of high-grade ore, the gradual fall in the price of the shares is not unexpected. There is now little opportunity for further economies or increase in percentage of recovery.

Burma.—There is no news of consequence direct from the mines at Mawchi, and the management in London has not yet yielded to the importunities of those who have asked for more information. The resignation of directors continues, F. W. Baker, R. Gilman Brown, T. J. Hoover, and A. F. Kuehn leaving the company, until there was only one active director left. The board has been filled by the appointment of representatives of the Southern Shan States Syndicate, which holds the control. It remains to be seen whether the difficulties of the situation are even yet properly appreciated. There are tin and tungsten at Mawchi, how much no one really knows, and there is a woeful lack of fuel, labour, food, and transportation such as is necessary to the success of a large industry in a sparsely settled, mountainous, tropical country. It is impossible under such conditions "to make haste rapidly" save with forethought and expenditure far beyond that which has been allocated to this enterprise. We regret to feel that neither the technical nor financial difficulties have been properly appreciated.

At the Burma Mines good progress is being made, but we defer a full report until next month.

Cornwall. — The position at Dolcoath causes anxiety, for the ore rich enough to pay at the present price of tin is being depleted. So many miners have gone to the war that vigorous exploration is impossible. Such work as has been done is disappointing, and on the deepest level, the 550 fathom, nothing has been disclosed. Negotiations are in hand with Mr. A. F. Basset, the owner of the mineral rights, in the hope that he will contribute to the fund required for sinking below this bottom level. As Mr. Basset has drawn £170,000 in royalties since the company was re-organized on a basis of limited liability in 1895, he might be induced to devote part of this money to the speculative chance of continuing his source of income. In the meantime, the Harriet and Stray Park shafts are being sunk to greater depths with the object of exploring in the sections adjacent.

Russia.—The directors of the Spassky Copper Mine Limited have issued a circular stating that financial and political conditions in Russia make it impossible to present the report for 1914 at the usual time, but that it should be possible to hold the meeting of shareholders in October. The profit for the year is estimated at £115,000, but as the rouble is at a heavy discount, the transference of the money from Russia to England has not been deemed advisable. In all probability the funds will be employed for the purpose of further developing the Atbasar property and providing the necessary plant.

The directors of the Orsk Goldfields company, dredging gold gravels in eastern Siberia, near the Okhotsk sea, have issued their report for the year 1914. The Kolchan dredge treated 641,600 cu. yd. for a yield of £37,182, and the Pokrovsky dredge 286,500 cu. yd. for £25,937, the yields per yard being 13¾d. and 21¾d. respectively. As compared with the previous year, the total gravel handled by the two dredges was 427,800 yards greater, and the total yield £7927 greater. The yields per yard at the two dredges were 5d. and 9¾d. less than in 1913. The tributers won gold worth £17,140, as against £3740 in 1913. The company's net profit for the year was £15,955, as compared with £679 the year before. W. H. Lanagan, the manager, left at the end of the season, and William Bach succeeded him.

United States.—In America as well as in the United Kingdom, industry is settling down to a steadier basis. While the railroads are not buying heavily and business is still uncertain, the great iron and steel trades are doing well and much of the buying is industrial. Recent changes in the rate of exchange have caused corresponding adjustments in metal quotations. At the same time increasing output has told heavily, and prices are back to a reasonable if not normal level. The copper exports for August amounted to 36,487,000 lb. According to C. E. Siebenthal, of the United States Geological Survey, the output of spelter was 207,634 tons made from domestic ores and 8898 tons from foreign ores, a total of 216,532 tons, as compared with 177,991 tons for the preceding six months, and with 175,058 tons for the first six months of 1914. In addition there was produced by distillation from drosses and skimmings 13,546 tons of secondary spelter, as compared with 10,273 tons, the half of the 1914 output of distilled secondary spelter. The spelter produced by re-melting skimmings, drosses, etc., was probably not less than 12,000 tons. The total output of spelter was therefore at the rate of 484,000 tons per year. The whole number of retorts in operation in June was about 127,000. Additional retorts to the number of over 32,000 have since been completed, are under construction, or are planned. The apparent domestic consumption for the six months period was 160,906 tons, as against 149,762 tons in the preceding six months, and 149,306 tons in the first six months of 1914. The spelter stocks on hand at smelters were 5884 tons, an average of about 150 tons each for the plants reporting. Rapid progress is being made in building the new zinc smelters of the United States Steel Corporation, and other smaller plants are coming into operation at a surprising rate. Still another tin smelter is announced as about to be built, the Standard Smelting Co. having been organized to erect a plant in the Pittsburgh district. According to the *Iron Age*, a Wile electric furnace will be used, and the plant will have a capacity of 20 tons of tin concentrate per 24 hours. This furnace has given good results in various metallurgical industries, and the trials on tin ore are said to have worked out satisfactorily. So far as known the men concerned are new to the tin industry. Ore is to be drawn from Bolivia. A number of British and American insurance companies have joined in the formation of a bureau, under the technical direction of Mr. H. M. Wilson, late of the U.S. Bureau of Mines, to apply the merit-rating scheme to mine insurance under Workmen's Compensation laws. For the present the activities of the bureau will be confined to certain states, but it is possible that later its benefits will be extended. There would seem to be no good reason why the standardization of safety and inspection methods might not even become international in time.

Mexico.—No definite progress toward pacification of this country is to be recorded this month. On the face of things, matters are as unsettled as ever. Whether below the surface real progress is being made, we can only hope. The Mexican Consul in London, Sr. Luis Mesa Guiterrez, has published an interesting pamphlet, 'The Truth about the Mexican Revolution,' that we commend to our readers, though by no means accepting all of his conclusions therein. Senor Guiterrez is an ardent defender of Senor Venustiano Carranza, and the programme he outlines as that of the Constitutionalists is one to which few, if any, exceptions can be taken. We must, however, reserve a doubt as to its entire workability, though we have no doubt whatever that peace will not come to Mexico until there is a better distribution of land and taxes, in short, that the unrest is due to economic causes. We do not follow Senor Guiterrez in what he writes about his fellow Mexicans. The Magazine has condemned as heartily as any, indeed friends well informed on Mexican affairs have held us to have been unjustifiably severe, methods employed by Porfirio Diaz in ruling the country. At the same time we believe Diaz to have been a great ruler and a patriotic Mexican. We believe that today quicker progress would be made toward peace if a more liberal spirit of compromise could be brought into play.

Canada.—The Government has taken hold vigorously of the problem of local supplies of metals for making ammunition and has established a wisely guarded system of bounties in connection with spelter. Zinc smelters in both British Columbia and Quebec are being erected, as our Toronto correspondent relates. Poor phrasing, by the way, lead our correspondent in July to attribute to the Department of Mines functions regarding assessment work that belong, of course, elsewhere. We are also informed that the Department made no statement to the effect that few claims in the West were being recorded. Prospecting in Canada, we believe, has been temporarily eclipsed by interest in other things, though we do hear rumours of stampedes from time to time, but this we are sure is incidental and temporary, while at the established mines work is most active.

News has been circulated in England to the effect that a new find of gold has been made at Matheson, Ontario. Matheson is the name of a county immediately to the north of Night Hawk lake and northeast of Porcupine. It is stated that ore averaging 2000 oz. gold per ton has been taken from a shaft 100 ft. deep. The news has not so far been confirmed by the High Commissioner for Canada.

Japan.—High prices for copper accelerated progress here as elsewhere. The Ashio smelter is again being enlarged. The new stack and dust chambers were to have been finished in August. Milling tests are under way, and should soon be completed.

Poland.—Mining regulations issued by the Germans, according to the *Colliery Guardian*, provide that mining may be carried on (except in alluvials) by Germans without the consent of the land owner, while Russians and Russian subjects cannot conduct mining in specified districts.

Belgium.—Coal mines both here and in Northern France are being operated under indirect German control at about half time to keep men at work. The companies are losing money heavily. A limited amount of coal is allowed to be exported to Holland. Naturally the mining methods used do not make much provision for the future. Zinc furnaces have been kept partly in operation, though they must soon cease unless arrangements be made for the import of raw material. The great glass industry is at a standstill for lack of facilities for transport of glass sand to the works. Unemployment is serious, and the people have drawn on their savings until little remains.

Spain. — Mining conditions in southern Spain have been much disturbed by the war since, contrary to general first thought, the mines are worked mainly for the sulphur in the ore, copper being a by-product. A large part of the market being cut off, production has had necessarily to be curtailed. At the same time costs of supplies have gone up, coal in particular becoming a real luxury. This is so true that in some instances air compressors have been stopped and a return made to hand drilling. The tendency in this direction is reinforced by the circumstance that explosives, being a government monopoly, are extremely expensive and with hand work more careful placing of the shots permits economy in explosives as well as power. It is impossible to increase output rapidly, despite the demand for acid, owing to the shortage of acid plant capacity in the allied countries. The lead mines have been benefited by the war, but this merely evens accounts for the long lean years in between periods of high prices.

Colombia. — At the meeting of shareholders of the Nechi Mines (Colombia), Ltd., held in London on August 24, the chairman, Mr. F. W. Baker, announced that the construction of the gold dredge had been completed, and a cable received since then stated that it started work on September 1. The completion of the dredge was delayed owing to some of the plant having been ordered in Germany, and these parts had to be supplied by English makers. The capacity is 25,000 cu. yd. per week, and the yield is expected to be 4s. per yard. If no untoward circumstance arises, it will be possible in four months to meet the requirements of the £70,000 preference shares, according to which the profits are to be devoted to repaying the whole of the capital paid-up on them, before dividends can be distributed.

Notable Deaths. — Herbert Kynaston, director of the Geological Survey of the Union of South Africa, has died at an early age, being only 47. He was educated at Eton and Cambridge, and held a post on the Scottish Survey before he went to the Transvaal in 1903 to take the position of director of the Survey.—Frederick Prime, of Philadelphia, who died in July, acquired fame by his English translation of Von Cotta's Treatise on Ore Deposits.—Otto H. Hahn has died in Germany, where he lived in retirement for the last ten years. After graduating at Clausthal in 1863, he went to the United States, where he became famous as a lead-smelter.

EDITORIAL

AS readers are aware, it is not our practice to call attention in the Editorial columns to announcements in the advertising pages. But when the advertiser seeks no advantage to himself and desires only to perform a high public service, our rule is relaxed. We accordingly ask our readers to take note of the appeal for sand-bags that appears on page 45. Old bags of all sorts are required by our soldiers, and smelters and ore merchants should be able to supply their quota.

THE Government has commandeered the available supplies of wolfram and scheelite concentrates, and has fixed a maximum price of 55 shillings per unit of tungstic acid content. This action has been taken with a view of securing at a reasonable price the raw material for the high-speed steel required in the lathes of munition factories. In some quarters, the establishment of a maximum price is not considered a politic move, for Bolivian and Spanish supplies may be thereby diverted to other countries where the governments or private buyers are disposed to make more advantageous offers.

THE scarcity of zinc has caused a revival of interest in electrolytic methods of precipitation. Such processes have an advantage that is of value in the present crisis, for the plants are cheaper and are more rapidly built than the furnaces required in smelting. In earlier days the cost of current and the tendency of the deposited metal to reoxidize were severe handicaps, and one process after another had to be abandoned, the modified Hoepfner process used by Brunner, Mond and Co., at Northwich, being the sole exception. Since then, the cost of current has been reduced enormously, and devices have been introduced that secure a stable metallic deposit. In our February issue we gave particulars of an electrolytic process working successfully in the United States, and in our Précis this month we quote a description of a process in experimental use in British Columbia. Information is also to hand to the effect that Australian concentrate delivered to France is to be treated in this manner, and that an installation utilizing the water-power of the Welsh lakes is in course of erection.

MUCH important mail was lost when the *Arabic* and *Hesperian* went down. American correspondents of British houses must keep in mind the uncertainties of the times and be patient if letters are missed. Among other mail lost on the *Arabic* were a number of copies of the August issue of *The Mining Magazine* addressed to subscribers in Canada and the United States. We do not print many extra copies, and the loss was not known until after the type had been distributed, but we have secured as many copies as possible and, so long as they last, we shall be glad to send them to subscribers who failed to receive the copies addressed to them.

THE appointment of Mr. Van H. Manning to be Director of the United States Bureau of Mines is announced at Washington, and the news will be welcomed by all familiar with the internal workings of that important Bureau. Mr. Manning, as Assistant Director, was probably the closest associate of the late Dr. Holmes, and he is the one best prepared to carry out and consolidate the widely varied useful work already initiated, as well as to judge the advisable rate of expansion. Mr. Manning, like his predecessor, was formerly connected with the United States Geological Survey, having served as an engineer in the topographic branch some years before being transferred to the Bureau. He has shown excellent administrative ability and, if not so widely known among mining engineers as his predecessor, he is equally well liked by those who do know him. The United States Bureau of Mines is fortunate in the character of the men whose services it has been able to command. From the very first not only high technical skill but much unselfish labour has gone into the upbuilding of what is already one of the most useful institutions at the service of the mining industry.

MEMBERS of the American Institute of Mining Engineers and of the Mining & Metallurgical Society of America are enjoying the hospitality of their San Francisco fellows this week. Under the able chairmanship of Mr. Charles W. Merrill, a most attractive programme of papers and excursions has been prepared. Next week the International Engineering Congress will assemble at San Francisco, and despite the war it promises to be fairly representative, though necessarily much less largely attended than it would have been under normal conditions. Those of us who, far from such peaceful scenes, are thinking mainly of the men and material needed to end the War, are glad that the profession is big enough and vigorous enough to supply its full quota to the fighting line and to keep up its peace work unimpaired.

THE Zinc Corporation's contract for the sale of its concentrate to Aron Hirsch und Sohn, of Halberstadt, Germany, has come before the English courts again. Last year the courts refused to hear the case in the form in which it was then brought. Parliament has since passed an Act permitting substituted service on an enemy alien, thereby making it possible to bring a direct suit. Mr. Justice Bray gave judgment on September 7 in favour of the Zinc Corporation, and pronounced the contract entirely void as from the beginning of the war, not merely suspended until the end of the war as contended by Messrs. Hirsch. The defendants gave notice of their intention to appeal, but this is not likely to prevent the corporation from obtaining an immediate benefit from the decision. In this connection it should be recorded that the Australian Federal Government has passed a law annulling all contracts made between Australian producers and German buyers, but that the home Government has not taken similar steps in favour of British companies, such as the Zinc Corporation, operating in Australia. The necessity for a decision in the case of the Zinc Corporation against Aron Hirsch und Sohn is all the more important, as there is every probability of the Australian Government introducing legislation that will make it practically impossible for British companies operating in Australia to sell their concentrate to Germany under the old contracts.

SALE of the Swansea Vale zinc smelters to Mr. R. Tilden Smith has created much comment in the City. While Mr. Tilden Smith is connected with both the Burma and the Zinc Corporations we understand that these companies are not concerned in the purchase, it having been made as a personal matter by Mr. Tilden Smith and certain associates. The plant, enlarged and rebuilt, would form an admirable basis for treatment in the United Kingdom of the zine ores now going outside the Empire, but any such plans must now be gauged solely by probable post-war conditions. The emergency demand for spelter is being met, and it is a serious question whether the men and money necessary to any great expansion are not worse needed in other directions. If the smelter had been bought and enlarged a year ago, a desperate emergency would have been wisely met. Now it may be better to buy spelter until the time arrives for the readjustment of conditions in the zinc business that will inevitably follow the close of the war.

OUR letter from Cornwall gives interesting details of the recent meeting of the Royal Cornwall Polytechnic Society, an ancient but far from moribund institution. Indeed the 'Poly,' as its friends love to call it, is reaching out constantly into new fields for usefulness, and the proposal that it should organize definite research designed to improve the technology of tin dressing and china clay mining impresses us as sound and likely to prove immensely stimulating to local industries. We are glad to note that the proposed investigations are to be co-operative, with the Institution of Mining and Metallurgy responsible for the technical direction. With the

Polytechnic in Cornwall and the Institution at London working together, it should be possible to enlist the support of every element necessary to success. Such plans are in harmony with the new spirit which is bringing about the organization of our resources badly needed both for war and peace.

Sissert.

In our review last month we predicted favourable news from the Sissert so far as ore reserves was concerned. The report, which we review upon another page, fully sustains our forecast, though financially the showing made by the company last year was a poor one. In large part this was due to abnormal conditions as regards supplies and labour incident to the war, but it is not to be forgotten that the financial load carried by the property is decidedly heavy. We discussed the matter in July 1912 when the Sissert company was floated in London, and we have seen no reason to change our views as then expressed. Nevertheless the property is a good one and should earn large dividends. The Sissert estate is extensive, and the satisfactory orebody discovered by careful prospecting at Degtiarsky by no means exhausts its possibilities. This is a phase of the matter that has not always been fully appreciated, but it is evident that any unusual profit to be earned must come from the Degtiarsky and other orebodies not developed when the present company was formed. Fortunately the conditions are good for finding such ore, and the Sissert is a property which, badly handicapped by the original financial muddling, is making good because of excellent technical direction. It is a triumph of economic geology and good management. It would be difficult to apportion the credit, but a large part at least must go to Mr. Norman Stines, the persistently optimistic man on the ground, to Mr. S. H. Ball who, after studying the Kyshtim deposits determined the geological conditions at the Sissert, and to Mr. William Selkirk, upon whom as Consulting Engineer in London the burden of large decisions has fallen. We regret that the Sissert does not have the capital in hand for immediately taking advantage of the new discovery, and we fear that there may be delay in inducing more money to go into the enterprise. However, past mistakes are not necessarily fatal, though the engineers concerned deserve all the more credit when, as in this case, they overcome their results.

Extralateral Rights.

Litigation between the Amalgamated Properties of Rhodesia and the Globe & Phœnix Gold Mining Company is attracting attention to extralateral rights, a matter with which British courts have fortunately had seldom to concern themselves. Because of the great burden of expensive litigation over such rights borne by mines in the United States, there is a general belief that the extralateral right is a Yankee invention. This is hardly correct, though the Americans have developed the doctrine to greater extent and with more ingenuity than have the people of other lands—and have suffered in proportion for their pains. Speaking broadly, however, miners have made their own laws, and in nearly every land the enactments of Parliaments and Legislatures have been in effect only codifications of local rules and customs already in operation. In many lands and at many times the elementary justice of giving the prospector what he has found has appealed to the men on the spot; so in many countries the rule that the miner is entitled to follow his ore into the ground, provided he shares with others the outcrop along the strike, has led to the establishment of some sort of extralateral rights. The whole history of legislation and litigation on this point has been of attempts to define these rights. In most of the progressive mining states the attempt has been abandoned as not worth the effort and the rights themselves have been abolished. In Saxony, where small well defined veins were worked, justice in permitting the miner to follow his vein on the dip could be realized without, as far as records show, entailing a great burden on the industry as a whole. In Derbyshire, where, too, extralateral rights were recognized long before mining began in America, we have not learned of any great evil resulting. So long as mines are small and the pits are worked mainly by their owners, the chance of conflict is not great, and any dispute that does arise is not likely to affect the politics of a whole state, as once happened in Montana. The miners of Derbyshire, Cornwall, and the Saxon districts took with them their ideas of mining law as well as of technology when they rushed to the goldfields of Australia and California. We know of no satisfactory historical evidence of the reproduction in either country of the actual rules obtaining in the old. On the face of it the miners in both of the new regions worked out their own laws, though there is strong presumptive evidence that they were guided by what had been the custom 'back home.' In Victoria extralateral rights, established first by custom, were later confirmed by legislation, but, after eight years of definite legal status, the rights were abandoned and the laws repealed. This was, later, the history in British Columbia, where it needed only a short period of actual operation of the law to demonstrate its faults, and it was promptly repealed. It is an interesting coincidence that the United States, as Mr. A. C. Veach has shown, enacted into national law the principle of extralateral right in the very year and month that Victoria abandoned it. In South Africa the introduction of the principle is attributed to the influence of American mining engineers and particularly of Mr. John Hays Hammond. Fortunately, and for special reasons, there has heretofore been little litigation. We fear that unless the law be changed the litigation will prove to have been but deferred. If so the cost will be heavy, since a whole system of interpretation and precedents must be set up. It will not be possible to make short cuts and draw upon American experience, because in the first case the findings of an American court naturally do not stand as precedents in a British court, and also because the Rhodesian law differs in important details from that in the United States.

Before discussing these differences, and lest the reader may be led to think that only Anglo - Saxons have been drawn into this quagmire, it may be mentioned that the principle of extralateral rights has obtained a certain footing even in countries that follow the rule of the civil law. In France, for example, while the boundary planes of a concession are in fact vertical, there is, we believe, nothing to prevent a concession being granted with planes at any angle. Whether this has ever been done we are not informed. In Spain and Spanish American countries, the admirable general principle of defined vertical boundaries obtains, but there is a loophole, and as early as the sixteenth century litigation arising at Guanajuato in Mexico, and carried to Granada for final settlement, pointed this out. In fact one of the great difficulties in the way of financing a vigorous development of Bolivian tin mines today rests upon a principle then established, later recognized in the code of 1587, and still the law in Bolivia. It amounts to this, that a miner may follow his ore underground outside the limits of his surface rights, and in unappropriated mining ground, the ore belonging to the miner who gets to it first. This constitutes a reward of diligence, but also works much hardship. Under the original decree a miner might even work under a neighbouring claim and was entitled to the ore he took up to the time that the mines met, after which he was to withdraw to his original claim. Under the Mexican system, established by this old decree, when one mine broke into another, a boundary pillar was erected, and after that each proprietor was to mine only on his own side of the mark. This system places a premium upon driving to the limits of an orebody quickly, and to that extent is a good thing, but it also opens the way to big mines from little outcrops, to underground wars, and worst of all it imposes a policy of absolute secrecy about underground conditions. It is difficult under these conditions, in certain Bolivian districts, even to make such a mine examination as is prerequisite to purchase and development of a mine along modern lines.

Fortunately the Rhodesian law is not so bad as the worst phases of this old Spanish system, though it includes pitfalls enough. Starting with the Mashonaland Mining Regulations of 1890 it has been amplified and altered from time to time by numerous decrees, though the more appalling task of obtaining court interpretations is still to be faced. In its simplest form the extralateral right permits a miner to follow his ore in his vein, on the dip, and prohibits him from working in other directions, usually defined by the end lines of his claim indefinitely projected as vertical planes. In the Rhodesian law, as in the old law of 1866 in the United States, it is the vein rather than the ground itself that is given. As a result, special action is necessary to secure rights to any other veins apexing or presumably apexing within the limits of the claim. This is complicated by the original Mashonaland regulation conferring a right to " follow the reef in all its dips, spurs and angles and variations " — terms, be it noted, not yet defined by the courts—and the wording of the 'Mines and Minerals Ordinance of 1895' which says:

> (b) Reefs, veins, lodes, or ledges. These terms shall be used synonymously and interchangeably with a more comprehensive meaning than their technical definitions convey, and shall be understood to include all forms of ore deposits occurring in the earth's crust that have been deposited subsequently to the formation of the enclosing rock, etc.

This is certainly broad enough to include anything likely to come into controversy, and it does not help greatly that " Beds of Iron, Salt, etc., and Mineralized Zones and Alluvial deposits " are excepted. We fancy that much conflicting testimony will be necessary to establish whether certain bodies of ore are " mineralized zones," and so excepted, or fall within the very broad definition already quoted in part. Originally the Rhodesian law applied only to gold veins which, at least frequently, have such regularity as makes it often applicable. Later, as in the United States, it was broadened and now applies to all ores of metals. Another complication arises from the fact that it is the right to follow the ore, rather than the ore itself, that is conveyed. It may be argued that it is only by following the vein from the surface downward consecutively that the right to mine outside the claim may be exercised. This, in many situations, precludes economical work and may take all value out of the right. The more one looks into the situation the less certain anything seems, and if the suit now before the courts should serve to induce Rhodesian authorities to imitate the good example of Victoria and British Columbia instead of the bad one of the United States, and abandon the whole system of extralateral rights, it will have served a most useful purpose. The courts will have enough to do determining existing rights, and districts yet to be discovered will be freed from a certain burden of pernicious litigation. Even in the United States a strong effort is now being made to abolish the right. Experience would seem to have proved abundantly that the burden of establishing and maintaining extralateral rights costs a country more, though individual mines may profit, than it is worth. The germ of the idea is good, but practically it has not proved feasible to apply the principle without greater injustices than those it was designed to prevent.

British Shops and Mining Machinery.

There is a mistaken impression in some quarters that the present rush of work in connection with war material in the engineering shops is seriously limiting the manufacture in England of mining machinery. The actual position is that the Ministry of Munitions has rightly considered that the production of metals, especially gold, is one of the industries that is of direct importance in the present conduct of the war, and in the future commercial recovery of the Empire. As a consequence of this view, the authorities look sympathetically on such manufacture of mining machinery as is necessary, even by controlled shops; and so far there has been no difficulty in placing orders in this country for all regular mining requirements. In fact, the stoppage of orders to Germany has led to an increase in certain supply lines for England; and manufacturers here are of course desirous of keeping the trade, particularly with a view to the future needs of their shops when war work is at an end. We have been at some pains to learn, by visit and by letter, the exact facts in regard to shop conditions in the United Kingdom. Virtually all the manufacturers of mining machinery are engaged on war work and all have suffered somewhat from the loss of good workmen. New men are, however, being trained, new shops are being built, and changed conditions are permitting a much more effective use of plant than before the war. As the new Ministry of Munitions becomes more completely organized much of such delay as is now inevitable will disappear. It is to be remembered that making shells is not the only phase of war work, and by allotting to each shop the special work it can best do, an excellent rate of output can be maintained. Last week a maker of rock-drills, after an earnest effort to plan otherwise, declined to undertake making fuses for shells for want of the right equipment. He is busy, however, turning out tripods for machine guns, for which the plant used in making rock-drill tripods is well adapted, and in making other things equally essential. The general rearrangement and speeding up in the shops incident to the war has resulted, in places, in even better deliveries than normal. There was a time last autumn when certain manufacturers were unable to guarantee delivery, but that has generally passed, and it is only on special work that there is unusual delay. It would be helpful, always, and especially so now, if mine managers would anticipate their needs as far as possible and give the manufacturers the maximum amount of time. Naturally each manufacturer wants to do as much of the war work as conditions will permit, and to be able to gauge in advance the wants of his regular customers is of great assistance. A most encouraging phase of the situation is the growing recognition of the fact that Britain has, if anything, been over generous in sending men to the front and that a skilled workman may serve his country quite as well making mining machinery at home as doing unaccustomed work in the trenches.

The High Commissioner for South Africa has taken some personal interest in the matter of uninterrupted deliveries of all supplies necessary to keep the gold mines up to their full production of the metal so necessary for the financing of the extraordinary calls on the resources of the Government. While shipment of mining machinery from the United Kingdom to the Union of South Africa in 1914 fell off slightly from the totals of previous years, all demands have been so far met. This is a matter of first importance as, to win the war, gold is needed quite as much as are explosives. A big mine equipped with rock-drills, for example, of a particular type, would be obliged to close if the supply of new drills or spare parts were cut off. To change to another type or make is too expensive an alternative, besides which steady delivery of one type is about as certain as of any other. It is to be remembered that in the United States, as well as in this country, makers of mining machinery have taken large war contracts, and that all over the industrial world there is a shortage of men for service in the armies. There are odd compensations. The increased cost of coal in Spain makes machine drilling temporarily more expensive than hand work, and the cutting off of the German market for pyrite at the same time decreases the amount of mining done. This largely withdraws Spain from the market and makes it the easier to meet the demands of the Rand, Russia, and neutral countries. The big factor is that German manufacturers are now out of both neutral and belligerent markets. In times such as this it is natural that there should be some confusion, but we are glad to record that in this field the period of disturbance was short. That the Ministry of Munitions recognized from the first the necessity of protecting peaceful industry as well as "rushing out the shells" is an expression of the fundamental common-sense of the British, not always fully recognized by our friends abroad, and it is the best of auguries for the future.

The Potash Salts.

In previous issues we have devoted much space to a consideration of the effect of the war on the production and consumption of the industrial metals, and of various chemicals such as cyanide and the organic compounds used in the manufacture of explosives and dyes. It remains for us to make note of the present position of the salts of the potassium group. Here we find the war upsetting the customary commerce of the world to a degree even greater than in the case of zinc, for the main supply of soluble potassium salts, at Stassfurt in Germany, is for the present unavailable for the requirements of England, France, and America. The raw material is almost unobtainable and the current quotations of potash salts as used in the arts and industries are fabulously high. Attempts are being made in various countries to revert to the ancient sources of potash, to find modern and rapid processes for preparing the salts from igneous rocks, and to develop natural deposits similar to those at Stassfurt. By far the largest proportion of the potash salts are used in a raw state as fertilizers. All plants require potash, some more than others. To some, the addition of extra potash to the soil acts as poison, while in other cases, as with beet, the tobacco plant, the vine, maize, and barley, additional potash is very stimulating. The raw salts chiefly used for this purpose are carnallite, the double chloride of potassium and magnesium, and kainite, the double chloride and sulphate of the same metals. These, with the chloride, sylvite, form the bulk of the deposits at Stassfurt. Of other natural salts, potassium nitrate, or saltpetre, is the most important, and in the earlier days was the chief salt produced. It was found as an efflorescence in certain earths where the mineral and organic constituents reacted for its production. Commercial methods based on this natural reaction were devised, using lime, the ashes of plants, and animal excreta. Saltpetre is still manufactured in India by this process. The uses of the salt are manifold, but the chief was and is still the manufacture of explosives. It forms the chief ingredient of gunpowder, and it is also a constituent of modified dynamites such as gelignite. For many purposes it has been replaced by sodium nitrate since the discovery of the Chilean deposits, and the American modified dynamites form a good example of this substitution. During recent years most of the potassium nitrate of commerce has been prepared by reacting with Stassfurt potassium chloride on Chilean nitrate of soda. The other potassium compounds of commerce occupy a long column in the chemical merchants' price-lists. Bichromate and prussiate are the bases of dyes and colouring matters, alum has many applications, bromide and iodide are useful medicines, and caustic potash is required in the manufacture of soft soap, and of glass used in the manufacture of chemical apparatus, optical lenses, and imitation gems. Permanganate of potash is a disinfectant and oxidizing agent, and one of its applications in mining is as a cyanicide for treating sandy tailing before the use of the latter for filling exhausted stopes. The fact that permanganate is now quoted at £300 per ton is a serious matter for the mines of the Rand. In connection with many of the salts, it should be mentioned that potassium is not the element of chief importance, and either sodium or ammonium can be substituted. It is indeed fortunate for the metallurgists that sodium cyanide is now in general use instead of the potassium salt.

As potash is disseminated so widely in the animal, vegetable, and mineral worlds, it is obvious that the sources from which it may be produced are many and varied. We have already mentioned that saltpetre is obtained by the reaction of animal and vegetable matter on certain minerals. In some places potash salts are obtained from sea-water, but this source is usually tapped through the instrumentality of sea-weed, which contains a surprisingly large amount of chloride and sulphate. Around the coasts of Scotland and Ireland the weed collected by the peasants provided an important supply of potash salts in the old days, and recently the industry has been revived to a limited extent. The weed is collected, dried, and burnt, and the resulting ash, called kelp, is in strong demand at present among chemical manufacturers. The word 'kelp' is of variable application, for in America it is often used to denote the raw potash-yielding sea-weed. Sea-weed in its raw state is used as a fertilizer in the south of England and France. On the coasts in some parts of the world the weed is a positive nuisance, and is regularly cut away to make room for shipping. Often it is merely dumped upon the land as rubbish, and no attempt is made to treat it for its valuable content. Both the English and United States Governments are taking active steps to foster the utilization of sea-weed, and in America in particular some excellent literature on the subject has been published. A source of potash that is of interest etymologically is the ash of burnt wood and vegetables, the ash being lixiviated in pots. The leaves of trees are valuable for producing leaf mould, but the stalks and stems do not decay in the same way as the leaves, and to obtain benefit from them it is necessary that they should be burnt and their ashes dug into the damp ground. In the fermentation of grapes, tartrate of potash accumulates on the vats and is recovered and sold. The excreta of many animals, notably sheep, are rich in potash, and the grease in wool fleeces contains it in large quantity.

The sources of potash of most interest to the miner are the igneous rocks and the deposits of soluble salts. As regards the latter we have already mentioned the Stassfurt deposits, which occur between the Trias and Permian rocks and are associated with rock-salt and gypsum. Attention has been turned in recent years also to the deposits at Cardona, near Barcelona, Spain. The deposits here, unfortunately, appear to be patchy and may never prove to be of much value. Our readers are familiar with the deposit at Searles Lake, California. In this arid region there are many accumulations of soluble salts, but until recently attention has been confined to the immense quantities of borates. These deposits represent the salts contained in a great Quaternary lake evaporated nearly to dryness. The potash salts, being the most soluble, are found in the brine. Wells sunk here yield a brine containing sodium chloride, carbonate, sulphate, and biborate, together with about $5\frac{1}{2}$ to 7% of potassium. The recovery of the various salts requires fractional evaporation under peculiar conditions and the commercial process to be adopted is still under study of the chemists. It is doubtless only a question of time until an important output is secured from this source. The development of the Searles Lake deposits has been due mainly to British initiative, for the Consolidated Gold Fields of South Africa has a controlling interest in the enterprise and has backed it firmly through all the initial difficulties. Potash salts have also been mined in Chile and the deposits are now receiving the attention of American capitalists and engineers. The number of deposits of soluble salts throughout the world is of course limited, and they offer little opportunity for investigation on the part of mining engineers and geologists. On the other hand the potash minerals of the igneous rocks afford excellent opportunity for research. There can be little doubt that the potash salts distributed throughout the soil came originally from these insoluble minerals by slow bacterial reaction with organic acids, and the technical consideration is nearly allied to the theorizing with regard to the formation of kaolin. There are records that early workers obtained potash by roasting granite with lime. The minerals high in potash content are orthoclase or potash felspar, muscovite or potash mica, leucite, a member of the felspathoid group, and alunite, an insoluble alum. Of these, the last-named has been used since the earliest time for the manufacture of alum, and sulphate of potash and alumina can be readily separated from it. In Italy leucite has been used for the production of carbonate by roasting with lime or soda salts, but the cost is too high. Much experimental work has been done in the United States with a view to obtaining potash from leucite and from felspar, but so far without practical result. In our issue of February 1913 we gave an outline of several of the most interesting processes, and those of our readers desiring further detailed information cannot do better than consult a pamphlet recently issued by the Imperial Institute. The difficulty is to find large enough deposits of the insoluble potash mineral free from admixture with the other minerals that go to build the igneous rocks, or to evolve a process sufficiently cheap for direct attack on the igneous rocks. The subject affords an excellent line for research, and success is sure to reward the efforts of some fortunate investigator. We have said at the beginning of this article that the war is the cause of the shortness of supplies of potash and its salts. This statement is true as far as its immediate application is concerned, but the difficulties of users outside Germany commenced three years ago when a heavy export duty on Stassfurt salts was imposed. The reason for this prohibitive tariff was not clearly seen at the time, but by experience we become wise, and we can class this tariff with the accumulation of copper stocks and the securing of long-time contracts for the supply of zinc concentrate.

CONDITIONS AND COMPENSATION OF LABOUR IN SARDINIA

By CHARLES WILL WRIGHT.

The lead of which the water pipes of Herculaneum were made came from the Sardinian mines. In those days men were driven to their task by whips. Now the Sardinian miners enjoy the benefits of workmen's compensation laws, ample safety regulations, old age pensions, and even in part profit-sharing. While efficiency and wages are low the cost of living corresponds and the accident rate is exceptionally low. The industry is flourishing.

TWENTY CENTURIES AGO AND TODAY. — When the Sardinian mines were operated by the Romans for lead and silver, slaves or convicts were the labourers. The lives of these workmen were not considered of much value and the foremen often used whips to get the required efficiency. They worked the mines by sinking narrow winzes or shafts in the rich ore-shoots and hoisted the ore in baskets, only the richest ore being extracted. Fire and water were used to help break the rock and it was much easier to sink a shaft than to drive a tunnel. At some of the mines ancient shafts have been found extending to a depth of 280 metres, and it is these early workings that are the main guide for present explorations. The tortuous irregularity and narrowness of some of these shafts are so remarkable that one even suspects that the miners who made them were smaller in size and could live on less air than nowadays. It was however from these burrows that the lead was obtained out of which the water-pipes of Pompeii and other Roman cities were wrought.

After the period of Roman administration the island was depopulated by wars and the mines were abandoned until the invasion of the Pisans in the XIIIth and XIVth centuries. The Pisans established laws permitting private parties to operate the mines, and regulations requiring them to protect the miners against accident and to provide proper ventilation and passage ways to the workings. They left many interesting records, and it is stated that the annual output of the mines in certain years was worth over a quarter of a million pounds.

The mines were again idle for a few centuries until the government leased them to a Swede named Mandel in 1746. He renewed mining operations and built a smelting plant at Villacidro, but in the middle of this activity, in 1759, he died and the mines which were then taken over by the government were soon closed.

The present period of mining activity dates from 1860 after well-defined laws had been established permitting free explorations for minerals and the granting of mineral land concessions. Though the progress in mining and milling methods has been somewhat slower in Sardinia than in other mining districts, the present Italian mining laws and regulations to prevent accidents and for compensation to injured workmen are probably more advanced and more effective than in many other mining countries.

Today the annual production of lead and zinc ores in Sardinia averages about £1,000,000 in value, the Iglesias district being the most important mining region in Italy. The mines for the most part lie within an area 15 miles wide by 30 miles long. They employ about 15,000 workmen who receive an average wage of from 2·50 to 3·00 lire. This wage is exceptionally low, though the cost of living is correspondingly low, as well as the amount of work done per man.

GENERAL LABOUR LAWS.—Every workman to obtain employment in the mines must present a passport giving his name with place and date of birth, while the mining company is required to furnish each workman with a pay book which the workman presents twice a month and in which is recorded the amount of pay he receives.

There is an 8-hour law for underground labour and the shift starts at the time the miner enters the mine and lasts until he is out again, thus only about seven hours of actual work is accomplished. Under no condition is a minor under 13 years of age allowed to work underground. The surface labour works 10-hour shifts and special permission is given to allow boys from 12 to 15 years of age to work at hand sorting and other light work, providing that they have a matriculation book properly filled out and signed by the Mayor of their home town. A workman must be given six days notice before being discharged or be paid six days wages in advance. Every workman must have one day's rest each week. Work at the mines on Sundays is only allowed for work which is absolutely necessary or in case there has been a holiday during the previous week.

To prevent accidents the Italian government has established rigid regulations for the protection of miners working in stopes, shafts, also for ladderways, in tramming and in the use of explosives. In case of a serious accident where the cause can be directly attributed to neglect on the part of the mining company to carry out the government regulations, the mining captain as well as the mine manager are liable to a fine or imprisonment. Because of the caution taken by the mine managers the cases where the government has carried out such punishments have been exceedingly rare, and since the law of 1904 requiring the mining companies to insure the workmen against accident regardless of the cause, there have been no cases of punishment of the mine officers. Though this law is rarely put into effect, it nevertheless tends to make mine managers more careful in seeing that their mines are kept in a safe condition for the workmen.

MINE ACCIDENTS.—The mining accident statistics for the last 12 years, 1903 to 1914, for the mines in Sardinia and the indemnity paid for accidents were as follows:

	Lire*	Lire per man
No. of workmen employed 15,233		
Annual pay of workmen employed	10,285,452	675
Annual amount of indemnity paid	189,456	12·43
Indemnity per 1000 lire of pay roll	18·43	
Approx. value of annual production	24,000,000	
Value of production per man killed	1,870,000	

*The value of the lire is in normal times a trifle less than 10d.

	Average per year	Per 1000 workmen
No. of workmen killed	12·83	0·84
,, ,, ,, completely disabled	0·90	0·06
,, ,, ,, partly disabled	88·50	5·81
,, ,, slight injuries not permanent	1915	125·7

Of the fatal accidents 40% were caused by falling rock, 20% by falls in shafts, 10% by tramming, and 30% by other causes.

The metal mining statistics of other nations show the following number of workmen killed per 1000 employed:

United States	3·09
United Kingdom	1·14
France	2·02
Spain	2·65
Germany	1·07

The above results of only 0·84 workmen killed per 1000 employed in the Sardinian mines as compared with those of other countries is a credit to the mine managers as well as to the Italian mining laws and regulations.

WORKMEN'S COMPENSATION.—In 1904 the Italian government established laws compelling all industries to insure their workmen against accident while at work without regard to the cause of the accident or whether the injury was or was not due to negligence on the part of the employer. These laws also set forth the amount of indemnity or insurance the workman is to receive in case of accident. This indemnity is based on the amount of annual wages received by the workman as follows:

1. In case a workman is killed his family or heirs receive an indemnity equal to 5 times his annual wages.
2. In cases of complete permanent disability the workman receives an indemnity of 6 times his annual salary or a minimum of 3000 lire.

   Under complete permanent disability are considered the loss of both arms or hands; the loss of both legs or feet; the loss of one hand or arm and one foot or leg; the loss of sight and the loss of mind.
3. In case of part permanent disability the workman receives, in proportion to his disability, a percentage of the above amount allotted for complete disability or a minimum of 500 lire. For partial permanent disability the following percentages of 6 times the workman's annual wages are paid as indemnity:

	Per cent.		Per cent.
Loss of right arm	80	Loss of thumb, right hand	30
,, ,, left arm	75	,, ,, ,, left hand	25
,, ,, right hand	70	,, ,, forefinger, right hand	20
,, ,, left hand	65	,, ,, forefinger, left hand	15
,, ,, thigh	70	,, ,, fingers or toes	5·15
,, ,, leg above knee	60	,, ,, sight, one eye	35
,, ,, leg below knee	50	,, ,, hearing, one ear	10
,, ,, foot	50		

Example: Workman loses right hand, annual wage is 750 lire, indemnity = 750 × 6 × 0·70 = 3150 lire.

4. In case of temporary disability caused by accident the workman receives half pay and all medical and hospital service free until completely recovered.

The Italian law basing accident indemnity on the workman's wages has not been adopted in other countries. The German law distinctly defines that the valuation of the damage and amount of indemnity to be paid for accidents must be determined for each individual case. The Italian law stipulates definitely the amount of indemnity according to the value or earning capacity of the individual.

ACCIDENT INSURANCE SYNDICATE.—In 1898, six years previous to the time the law of 1904 went into effect, the mining companies in Sardinia made provision for the insurance of the workmen by the formation of a 'Sindicate per gli Infortuni sul Lavoro nella Coltivazione di Miniera' which corresponds to a mines accident insurance syndicate. This Syndicate was organized so as to establish a fair basis of compensation to the workmen in case of injury and to diminish the lawsuits and lawyers' fees. The initiative in the formation of this Syndicate was taken by Comm. E. Ferraris, former general manager of the

Monteponi mines, who has done much for the welfare of the workmen and for the mining industry in this district. At the start there were some mines which would not join the Syndicate, but they all participated, especially after the law of 1904 became effective.

The advantage of a mutual insurance syndicate controlled by the mining companies is that its endeavours are to protect the mining companies against lawsuits as well as to satisfy the workmen as to their compensation, while an outside insurance company would be inclined to pay as little indemnity as possible to the workmen and would not assume the same responsibilities in case of lawsuits.

The statutes of this Syndicate were drawn up to conform with the national laws and regulations and have the approval of the Minister of Agriculture, Industry, and Commerce. The mining companies all subscribe to the Syndicate in proportion to the number of workmen they employ.

The following are some of the articles of the statutes:

> The scope of the Syndicate is to insure all workmen employed by the mining companies against accident while at work in the mines or on the surface and to see that the government regulations to prevent accidents are carried out. The government mining laws and regulations in so far as they are applicable to mine accidents form a part of the present statutes.
>
> At the beginning of each year the participating mining companies are required to deposit the sum of at least 5 lire for each person insured.
>
> A report by the mine doctor on every accident must be sent to the office of the Syndicate within 48 hours after the occurrence of the accident.
>
> The mining company is required to reimburse to the Syndicate one-fifth of the sum liquidated for accident and to the workmen insured for them.
>
> Every three months all mining companies must furnish to the Syndicate a statement of the number of workmen employed, the shifts worked, and the total amount of their pay.
>
> The mining company must furnish to the Syndicate all data available to show the cause of the accident. The exactness of the data must be guaranteed by the mining company.

The Syndicate is managed by a council composed of five members, usually mine managers, and a president, who are elected at the annual meeting for all members. There is a director and a secretary of the Syndicate who receive salaries; and a doctor is called in to verify contested cases where the workman is not satisfied with the mine doctor's report on his case.

In case of accidents where a workman is killed or seriously injured the judge from the neighbouring town must be called to verify the cause of the accident, and an engineer of the Bureau of Mines is also called upon to make a report on the accident. In case of a lawsuit the decision of the court is based upon these official reports and the case is fought by the Syndicate.

The government requires as a precaution that all accident insurance companies have on deposit in the form of government bonds a minimum of 10 lire per workman insured. The Minister of Agriculture, Industry, and Commerce has the right to carry out, at any time, an inspection of the books of the insurance company and he must be advised as to all of the indemnity payments made by the company. The inspection of the mines to see that the government regulations are carried out is made by some member of the Bureau of Mines on rare occasions. In case of neglect to comply with the regulations the Inspector may fine the mining company, although he usually makes recommendations only.

Since the organization of the accident insurance Syndicate in Sardinia litigation against the mining companies has been practically eliminated and the miners receive more and the lawyers less than was formerly the case. The annual amount of indemnity paid by this Syndicate during the last 12 years for accidents to workmen amounted to 10·36 lire per workman insured or 15·35 lire per 1000 lire of pay roll. To this amount must be added the 20% of the indemnities which are paid by the mining companies.

Organizations of this sort by the mining companies in other countries would be of benefit to the mining industry and would help to eliminate the payment of high premiums to insurance companies as well as to reduce lawsuit expenses, providing that they had the approval of the government and State.

INSURANCE AGAINST SICKNESS. — The workmen in Sardinia, instead of paying high fees to labour unions as in other countries, have organized among themselves societies for mutual assistance. There are several such societies at the different mines and neighbouring towns, all of which have similar statutes. Their scope is to provide moral and material benefit to the members.

Members must be from 18 to 50 years of age and are elected at the regular meetings. The entrance fees vary with the member's age from 9 lire to 60 lire, the latter amount being for men over forty-five years of age. The regular fee is 1·50 a month. The members receive medical assistance and medicines free of charge in case of illness, when they are not resident at the mine and so have the free services of the mine doctor. During the period of sickness or convalescence the members receive one lire per day for the first two months and after that 75 centimes per day for a year, and during the second year the amount is reduced to 50 centimes per day, or some other arrangement is made. In case of death the widow or children of the members receive a subsidy of about 250 lire per year for 2 years.

These societies have club rooms, furnished either by the mining company or by themselves, where they gather for games and reading. The membership of these societies is increasing each year and they are highly approved of by the mining companies.

NATIONAL PENSION FUND.—In 1898 the Italian government instituted an insurance for workmen against invalidity and old age. To start with, the government subscribed 10,000,000 lire to this pension fund.

All Italian workmen under 45 years of age are permitted to participate in this insurance. By paying a premium of 6 lire or 9 lire a year a workman can begin to receive his pension respectively at 55 or 60 years of age, provided that he has subscribed to this fund for 25 years. Having paid his premium for 5 years or more a workman, who through accident or sickness becomes unable to work, receives a minimum pension of 120 a year. In case of death all premiums paid by the workman are returned to his family.

After 55 years of age a workman who has paid a premium of 9 lire or more a year receives a pension, the amount of which is determined by the total amount of premiums he has paid, plus 10 lire which is added annually from the pension fund, plus an annual interest on these amounts which amounts to about 4%. The usual pension amounts to about 25% of this total amount. Thus if a workman has paid a premium of, say, 12 lire, which is the usual amount paid, for 25 years he will have a credit of about 880 lire and receive an annual pension of about 220 lire. Each participant is furnished with a book and his premiums can be paid at any post office and credited to the individual.

CAPITAL AND LABOUR. — Schemes have been tried by which the capitalist distributes a portion of the mine's profit to the workmen in the form of an annual bonus. Probably the most satisfactory is the one that has been introduced at the Gennamari-Ingurtosu and Pertusola mines by Lord Hythe, president of these companies. The principal provisions he has established for participants of this bonus are as follows:

Only workmen who have been in the service of the company for 3 years or more are entitled to participate in this fund.

Every workman who desires to participate in this fund must insure himself in the National pension fund, the mining company agreeing to pay half the premium, which shall be 24 lire a year.

At the end of each year the workman who has paid his 12 lire toward the pension fund is credited with a percentage of increase in his year's wages corresponding to the percent of dividend paid by the mining company minus 5%. Last year, for instance, the company paid a 12% dividend and the workmen participating in this bonus fund received a 7% bonus on their total wages during the year or about 50 lire each.

The workman cannot withdraw any part of the sum to his credit until after he leaves the companies' service.

An interest of 5% is paid on all amounts to the credit of the participants at the end of each year.

No bonus is payable in the year in which a strike occurs.

Zinc.—Mr. Reginald Le Neve Foster has presented the Royal Society of Arts with a donation for the purpose of founding a prize in commemoration of his father, Mr. Peter Le Neve Foster, who was secretary of the society from 1853 to 1879. The Council has determined to offer the prize, which will consist of a sum of £10 and the society's silver medal, for a paper on 'Zinc, its Production and Industrial Applications.' The paper for which the prize is awarded will be read at one of the ordinary meetings of the society. It is expected that some account will be given of the history of the metal, the sources of its supply, its metallurgy, and the various uses to which it has been, or may be, applied.

Alcohol for Power.—The Board of Trade has issued particulars of prizes offered by the Russian Ministry of Finance in connection with the application of alcohol for various purposes. Many of the purposes specified come within the range of purely organic chemistry, but some of the subjects forming the basis for prizes are of interest to our readers. One relates to the invention or perfection of apparatus for the utilization of spirit as motive power, fuel, or illuminant, and another is intended to encourage the finding of novel denaturing materials and for improving the existing methods of denaturing, which, while guaranteeing the free use of denatured spirit, would obviate any possibility of using it as a beverage.

VISITING THE HUNAN TINFIELDS

By GILMOUR E. BROWN.

Far in the interior of China is a tinfield which can only be reached by 250 miles travel by boat and sedan chair from the Yangtsze river. The area shows a limestone country intruded by biotite granite. The tin at Lenshee occurs in sandy soil along the contact. At Shanwha five native companies produce 12 tons per month from veins where limestone has been intruded by acid granite. The native methods employed are described.

IN the course of professional work in the Far East, I left Shanghai at the end of February for an extended trip in the province of Hunan, which lies east of a central meridian through China and to the south of the Yangtszekiang, that river forming in part its northern boundary. My previous experience in China consisted of short excursions in the provinces of Kiangsu and Hupeh, among people to some extent accustomed to the ways and presence of foreigners. Although the contemplated journey was mainly concerned with tin deposits in the extreme south of the province and more accessible from Hongkong, other mines to be examined in the north and centre of the province compelled me to enter by the north and return partly over the same route.

From Shanghai to Hankow on the Yangtsze, a distance of 600 miles, comfortable double-deck river steamers run nearly every day, completing the journey in $3\frac{1}{2}$ days. Although the Yangtsze is navigable at all seasons as far as the rapids at Ichang, about 500 miles above Hankow, it by no means passes through flat country, and many hills and mountains of soft sedimentary rocks, for the whole or greater part, can be observed in close proximity to the river. A short distance in from the south bank and from Hankow, a Sino-Japanese company is working some lenticular contact deposits of hematite and magnetite.* Many of the contacts in this region are mineralized and show, in a matrix of secondary silicates, the sulphide ores of copper and lead. From Hankow during the high water season, shallow-draught British owned steamers run to Changsha, the capital of the Hunan province, a distance of 270 miles, and some to Siangtan, a few miles farther on, near the present terminus of a short railway to the Pingsiang colliery in the adjacent state of Kiangsi.

The river being at its lowest, I was not fortunate in finding these steamers running and was forced to take passage in a 40-ft. Chinese owned steam launch carrying 30 to 50 coolie passengers and possessing a few diminutive cabins. All cabins and bunks on such launches are apparently built for people of a maximum height of 5 ft. 4 in., consequently the three days and nights spent in one of these cabins, where it was impossible to stand or lie straight, was akin to imprisonment with torture.

Hunan is noted for its production of antimony, stated as equivalent to 19,000 tons of pure metal for the past year, and at the time of writing is experiencing the benefit of the great rise in the price of the metal. There are several Chinese owned smelters at Changsha, but one of a more modern type, using the Herrenschmidt process of volatilization followed by condensation of the oxide in towers, with subsequent reduction to metal is now under construction at Hankow. Chinese antimony is very pure, indeed according to the *Mining and Scientific Press* of November 14, 1914, Hwachang antimony from Hunan is purer than some of the better known brands, while then selling for $1\frac{1}{2}$ cents (U.S. Currency) less per pound.

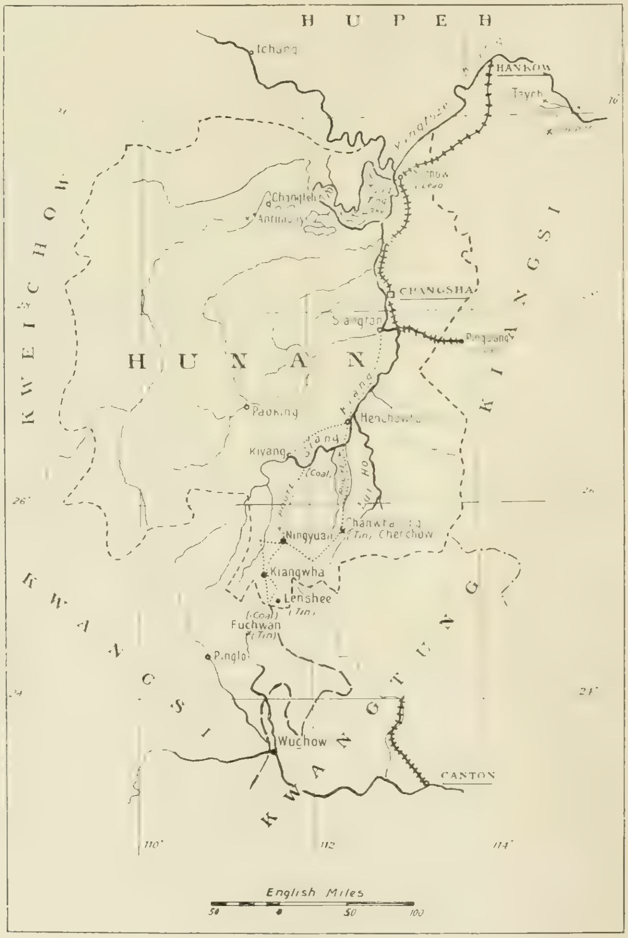
From Siangtan to Henchowfu, at the junction of the Lui-ho and Siang-kiang rivers, the main arteries of commerce of southern Hunan, travel by sedan chairs offered the quickest means of progression, Henchowfu being reached on the fourth day. At Henchowfu an agreement was made hiring 4 sedan chairs and 14 coolies at the rate of 11 pence per day per coolie for the round trip to the south and back, estimated at a month's duration.

South of the Yangtsze there are no roads worthy of the name, all goods being transported by coolies along tracks only 2 to 4 ft. wide, invariably paved with flagstones or pebbles. These tracks are mainly along the tops of dykes between grain fields, passing from contour to contour in an exasperating manner, adding greatly to the length of the journey. It is difficult to see how roads can be made for private enterprise without Government or State interference or arbitration, for virtually all the easily graded ground in the more populous districts is under cultivation with owners innumerable. In the towns, too, due to the necessity of utilizing the space within the walls to the greatest advantage,

* 'The Tayeh Iron-Ore Deposits' by C. M. Weld, Trans. Amer. Inst. Min. Eng., Vol. XLIV.

the streets are made very narrow and are usually badly paved, dirty, and at times strikingly odoriferous.

Educated Chinese are kind, courteous, and considerate, while the best that can be said for the coolies is that they perform feats of endurance daily in the transport of goods. The baggage coolies were loaded each with



Map of part of southern central China, showing the route of the journey.

80 to 90 lb., and with the exception of 4 half-days lost at the start and through business en route, they walked daily 18 to 23 miles during 16 consecutive days of travel. For a full day an average of 10 hours was spent on the road, of which about 7 hours was actual walking.

The only places providing sleeping accommodation are those which cater for the coolies at $2\frac{1}{2}$ to $3\frac{3}{4}$ pence for dinner, bed (no bath!) and breakfast, and often breeding pigs in the same habitation as a 'side line' in business. Away from the main route they quickly deteriorated into dark, evil-smelling, loathsome places, furnishing exquisite torture gratis even on one's own camp-bed and bedding.

The advent of a foreigner into the mountainous district of the south appeared to be a memorable incident in the lives of the inhabitants, due, no doubt, to the anti-foreign attitude assumed by the natives in the past. The curiosity of the people increased with progress into the country, and although the people were never friendly they were not openly hostile. Particularly were they interested in the foreigner's method of partaking of food, the midday halt attracting the population of the village en masse. The lack of a little privacy, day or evening, became rather trying, but when the country infested with brigands was reached, the escort of soldiers supplied kept the crowd at arm's length and no further inconvenience was experienced.

From Yochow on the Yangtsze on the north, to Kiyang on the Siang-kiang, some 250 miles, soft beds of mudstone, sandstone, and conglomerate were seen, showing gentle folding except in the neighbourhood of two granitic intrusions, where they were locally tilted and broken, but without much evidence of thermal metamorphism. Although they have the appearance of recent beds they are said to be of Carboniferous age. Two intrusions, both of biotite granite, were noted, one forming a mountain between Siangtan and Henchowfu and another with a comparatively small exposure about 30 miles north of Henchowfu. They are, as far as could be ascertained, devoid of minerals of economic value.

On approaching Kiyang, limestone was observed for the first time, the bed having a northeast strike and a conspicuously rough pinnacly surface, such as was constantly in view during many days thereafter. Limestone, as low rolling hills covered with a typical bright red soil, formed the valley of the Siang-kiang and extended to the base of a confused mass of mountains, blocking the trail to the south. These mountains were found to be of hard sandstones and slaty shales, the limestone extending a little way up the flanks. They contained at least one small exposure of muscovite granite. The trail, descending steeply from the mountains, followed the valley of a backward flowing tributary of the main river, exposing interbedded limestone and shale, passing later into limestone almost entirely.

South of Ningyüan the geological structure was more readily interpreted and confirmed previous deductions. From the limestone plain of Ningyüan a series of mountain ranges run with a general north and south direction to the southern extremity of the province. Two of these ranges were examined and found to consist of sandstone and shale and to represent the hard cores of anticlines, the intervening valley of limestone covering the syncline. A continuous record of dips over one of the ranges showed that the fold had given way near the crown of the arch and a large vertical component to the faulting movement is surmised. The direction of the folds does not coincide with that of the strike of the beds, the latter being the northeast-southwest direction so often noted south of the Yangtsze. East of one of the ranges, in a narrow valley only a few miles in width, there were several hundred sharp peaks of limestone, forming a wonderfully fantastic picture.

This mountainous region is infested with brigands with whom the Government is trying hard to cope, but funds are lacking. The miners, too, when making a little profit, are not overpleased at the arrival of a foreigner, believing that he will rob them of the mine. One mine on my programme I had to omit on this account, the magistrate at the nearest town, while offering a large escort, refusing to accept any responsibility for my safety and advising giving the place a wide berth. The journey was continued southward under an escort of 20 soldiers, and after 19 days of chair travel, with only minor zig-zags from the direct route, the tin deposits in Kiangwha, the most southern district of the province, were reached.

Practically all the tin from the Kiangwha district comes from the village of Lenshee, 5 miles from the boundary with the Canton (or Kwangtung) province, and according to the maps, of which no two seem to be alike, about 35 miles from the tin deposits at Fu Chwan in the Kiangsi province, described by M. G. Yung in a recent *Bulletin* of the American Institute of Mining Engineers.

As at Fu Chwan, cassiterite is found along the base of a biotite granite batholith with a northeast-southwest trend and nearly over the line of contact with limestone, into which the granite is intrusive. Although the actual contact was obscured it was evident that the limestone, though considerably folded locally, had suffered little from thermal metamorphism and that the zone of alteration could not be of any great width. Abundant magnetite and hematite, found chiefly in the tin workings, occasionally as blocks two feet in diameter, may owe their origin directly to the intrusion of the granite, the purification of limestone following on crystallization, or may represent the oxidation products of pyritic masses near the contact.

The greater part of the tin is found in a sandy soil, derived mainly from granite, and contained in a layer rarely more than two feet in thickness resting on an irregular limestone bedrock. The distribution is poor and patchy, and the Chinese method of working by shaft sinking followed by burrowing around the base of the shaft, is admirably suited to the nature of the deposit and the financial resources of the workers. A little tin is also obtained from the lower slopes of the granite by the customary method of leading a small stream of water to the face and raking the soil into the natural sluice which it forms. One vein containing about 2% tin is said to have been discovered in the limestone, but was not open to inspection.

The cassiterite is coarse and occurs as crystals with sharp edges with no signs of attrition, as well as in slightly rounded grains. Among specimens from the district were noted some white almost colourless crystals of cassiterite, with galena, pyrite, bismuth, and black tourmaline, all common associates of tin in veins.

The dressed mineral is smelted locally in small circular furnaces of a type which has been frequently described and can be seen in operation at several places in Malaya at the present day. The resulting tin is pure and is sent to Hongkong, its transportation offering little difficulty, involving 30 miles of porterage to a river flowing south through the Kwangsi province. The total production of the district is small, amounting to less than 100 tons yearly.

The greater part of this range is the stronghold of several hundred brigands, who up to the present have maintained the integrity of what they regard as their own territory against all comers. Further prospecting operations are thus impossible; indeed, the district is

THE TOP ILLUSTRATION SHOWS THE METHOD OF TRAVELLING BY SEDAN CHAIR. THAT UNDERNEATH PICTURES ONE OF THE STONE WAYSIDE RESTING-PLACES ALONG THE MAIN ROUTES. THE BOTTOM ILLUSTRATION GIVES A VIEW OF THE RIVER BOATS; THE LONG OAR IN THE BOW IS USED FOR SWINGING THE BOAT QUICKLY IN THE RAPIDS.

unsafe for Europeans. Usually brigands prefer not to molest foreigners, knowing well that the Government may be exhorted to send an expedition against them, but in this district the brigands have so secure a position, necessitating concerted action by three provincial governments, that the risk incurred by foreigners may be considerable, known as they are to furnish good trophies in the shape of rich baggage and fat ransoms.

Soon after arrival at Lenshee word was brought that brigands had descended on the trade route, three days' journey northwards, attacking and driving a small detachment of soldiers from their post, killing two, and remaining in complete possession. As the immediate return of my escort was desired on that account, the return journey was commenced next morning, making a detour to avoid the scene of military operations and seeking the shelter of fortified villages at night. On the third day of the return, the escorting soldiers, believing that a rifle discharged close at hand was the precursor of an attack, with great diligence and some excitement unslung their rifles and replied, but without drawing further fire from the supposed enemy.

The country lying between Lenshee and Shanwha-ling, the only other centre of tin mining operations in the province, is too mountainous and unsafe for travel, the latter place being reached only after a detour of seven days' duration through Ningyüan. At Shanwha-ling five Chinese companies are mining veins in a narrow gully almost completely encircled by mountains and producing about 12 tons monthly of a rather impure block tin.

About one mile from the mine crystalline limestone was found, evidently domed over an intrusive mass of a somewhat acid granite. It was evident that the granite had advanced also by block faulting, blocks of limestone on areas measurable in tens of acres having dropped bodily toward the magma, bringing limestone with little crystallization evident and with the fossils recognizable into contact with limestone (or marble) of wholly crystalline texture. None of the faults showed post-mineral movement, all containing minerals of which some are regarded as frequently formed at temperatures equal to or above the pneumatolytic stage of ore deposition.

The mines are grouped around a small portion of the limestone-granite contact and without exception the veins exploited were in the limestone. At one part of the contact the granite showed a narrow zone with abundant development of large phenocrysts of felspar and a few feet away, in a vein in marble, spherulitic aggregates of black tourmaline, 5 in. in diameter, with pyrrhotite, pyrite, fluorspar, and cassiterite in a calcareous matrix. One prominent fault plane, parallel to what may be a dike, with a smooth wall for a length of 200 to 300 yards forming the foot-wall of a quartzose vein several feet in width, shows, unfortunately for the future of the district, only a trace of cassiterite.

Permission was not obtainable to inspect more than a few of the workings and these were found to follow pipes rather than veins of mineral. It is believed that the average grade of the ore mined, even after considerable sorting and handpicking, is well under 2% tin. A feature of the district is the abundant occurrence of pyrrhotite in the tin veins and in masses several feet across, practically barren of tin.

The picked ore, which contains also abundant pyrite, some zinc blende, and a little galena, is roasted in furnaces of a peculiar design which recall Mark Twain's description of a Mississippi ferryboat as possessing a 2-ft. boiler and a 6-ft. whistle. The firebox is about 6 ft. in diameter and of the same height, while the receptacle for the ore takes the form of a short vertical cylindrical chamber about 20 in. in diameter and 2 ft. in length, built outside the base of the firebox on the opposite side to the firing door. Brushwood is used as fuel and the charge is roasted in 12 hours.

Crushing is performed in the foot-stamps universally used by the natives of Southern China for husking grain. They are in this instance adapted for water power, the cams on the shaft carrying the water wheel, forcing down the shorter end of a pivoted beam about 6 ft. in length, provided with a rough iron shoe attached to its other extremity. After crushing, the ore is concentrated partly in short sluices and partly on a concave surface,* tapering to half its width at the base.

The tin bars are carried by coolies northward to the nearest navigable river, a distance of about 46 miles, and from there in 30 ft. native boats to Henchowfu. That route was followed on the return journey to Changsha, a rapid passage being made owing to the flooded state of the river and affording an agreeable change from the tediousness of travel in sedan chairs.

In the first picture is shown the pinnacles of limestone characteristic of the tin district. In the second is seen the native concentrating device. The bottom photograph shows the native furnace used for roasting the tin concentrate.

* For detailed description see 'Tin Production in the Province of Yunnan, China,' by W. F. Collins, Trans. Inst. Min. and Met., Vol. XIX, 1910.

PROSPECTS FOR TIN IN THE UNITED STATES

By H. FOSTER BAIN.

The United States absorbs nearly half of the tin mined in the world and spends about £10,000,000 per year for the raw material. Despite the vigour and activity of mining in that country, no important local supplies of tin have been developed. This is not because tin is not present, but for the reason that up to now the opportunity for making profit out of other metals was better and there was no local market for crude ore. The average price for tin has been about double that for copper through the last 30 years. On this basis tin ores containing ½ to 1% tin might be mined in the United States and there are localities where such ores occur. While some tin mining is likely to develop, the United States will continue to afford a great market for foreign ores.

*I HAVE thought that you might be interested for a few moments in a discussion of why tin mining, your own greatest industry, never developed in the United States. The short and simple answer would be by reference to the ancient recipe for making a stew which, as you will remember, begins "First you catch your hare." In this instance, as it happens, the short and simple answer is not alone sufficient. Contrary to widespread belief, the United States is not barren of tin veins and, having for years extended a hearty welcome to all Cornishmen, there are within the United States many men who know tin and tin mining.

The United States is the largest buyer and user of tin in the world, spending approximately $50,000,000 per year for the metal. At present it absorbs not far from half of that mined, and yet there is now no tin smelter in the country, and the total output of tin ore has been so small as not to receive a separate place in the world's statistics. This is all the more surprising in view of the wealth and diversity of mines in that country, and the energy with which its mineral resources have been developed. A nation that produces 60% of the copper of the world, and in a single year has put into operation sufficient additional zinc smelting capacity to balance that withdrawn from the world's needs by the Germans, can hardly be held lacking in material, skill, or energy as to mines and metallurgy. The reason must be sought in other conditions.

The organization of the mining industry in America differs greatly from that in the British Empire. Briefly, the principal difference lies in the absence of a broad public market for mining securities. Company organization, promotion, and management have not reached there the high plane of skill and special knowledge that they have in Great Britain. The American public does not put its savings into mines or, to the limited extent that it does so, the movement is unorganized and the results are inefficient. As a consequence mining there must make its own capital. The public money goes into banks, insurance, railways, and, lately, into industrial corporations. The individual who invests his own small accumulations is most apt to buy land, a natural result of the long years in which cheap land has risen steadily in price. When, too, one can put money into well secured 7% first mortgages, the uncertainties of mining do not appeal keenly to those who are not miners. It follows that, speaking broadly, the miners have had always to work with their own capital and today the men who are leaders in mining in the United States are the professional, if not the geneological, descendants of the pioneers. It is only in the most recent years that these men have begun, in any large way, to tap the reservoirs of public money outside and bring it into mining. Now it happens that the tin veins in the United States that have so far been found are not of such richness as would enable them to compete for attention with the gold, silver, lead, zinc, or copper veins also open to the prospector and pioneer miner. The latter could make more money mining the other metals and so attention was diverted from the possible tin mines. Therefore, while copper, lead, and zinc smelters abound, and custom mills will buy gold ores, the prospector who mines a bit of tin has no place to sell it. This has long been true and as a further result a generation of prospectors has grown up of which probably not one in a hundred would know tin ore if he saw it. It was this, I believe, that prevented the growth of any tin industry in the United States. There are deposits that, granted a local market, might have been developed. This, of course, is a very different matter from deposits of such richness and extent as to enable them to make a market and to furnish their own capital while doing so. In point of fact the tin ore mined in the last few years on Cape York, Alaska, came clear to England (about 8000 miles) to find a buyer, and last year went to Singapore to be smelted. I suspect that such conditions would dampen

* From an address delivered before the Royal Cornwall Polytechnic Society, at Falmouth, September 1.

the ardour of even the indomitable tin miners of Cornwall. If tin smelters had been running, some ore would have been mined in the United States, but no mine yet found and opened has promised enough ore to warrant a smelter, and with the competition of other opportunities the investment of money in a long campaign of development has not proved attractive. In the two instances where money was lavished on the infant industry, at Temescal and Harney Peak, the work seems to have been directed more toward the immediate profits of the stock market than the ultimate making of a mine.

I would not be misunderstood. I do not know of any evidence warranting the belief that the United States will ever, from within its own limits, mine enough tin to meet its own demands. Indeed, that seems extremely improbable. It will mine some tin, but it will always be a heavy buyer of ore and probably also of metal. With the rapidly increasing use of tin such contribution to the total as any North American mines may hope to make, will not influence prices to any considerable extent. The demand seems sure to increase faster than the supply so far as present known sources are concerned. The Americas, both North and South, are great food producing countries, and the provision industries will continue to make heavy demand on the tin mines. It is not to be forgotten, however, that making tin plate is but a minor use for tin. According to the best estimates Mr. Edward Walker has been able to make, only 15 to 20% of the tin, at most, is used for coating plates. The bulk of the metal is used in making various alloys and compounds. For plate coating great purity is required. For other purposes metal of lower grade, such as comes from Bolivia, may be used. Among the effects of the war now in progress will be the establishment of tin smelting in the United States. One plant is now being built. Another, I understand, is about to be built by one of the best known British firms which prefers to follow a market rather than to lose it, and which will put into the business such another draft of experience and skill as will increase heavily the professional debt of America to the United Kingdom. Still other plants are in contemplation, though all are depending upon the purchase of ore in Bolivia and elsewhere. In the meantime the United States Steel Corporation, the world's largest user of tin, continues to supply its mills with metal from the Malay States smelted at Singapore, and brought to San Francisco on its own ships. Fortunately, there has been no interference with this trade.

With the promise of a local market for ore, there has been a renewed interest in the possibility of local supply. Those who may care to look into the matter in detail will do well to follow the 'Bibliography of the Geology and Mineralogy of Tin,' published by the Smithsonian Institution as No. 2 of volume 58 of its Miscellaneous Collections. Mr. Frank L. Hess, the senior author of this excellent work, is one of the well known economic geologists of the United States Geological Survey, and has served as the expert on tin for that organization for a number of years. For present purposes a much less exhaustive review will be more appropriate and in this I shall follow especially the excellent essay by Mr. William De L. Benedict, that forms one chapter of the first volume of 'The Mineral Industry,' supplementing it by notes of more recent date mainly from the *Mining and Scientific Press*.

According to Mr. Benedict, tin was discovered in California as early as 1840 by the Indians. The material was at first thought to be silver. That error having been corrected, a party of San Francisco capitalists in 1868 organized the San Jacinto Tin Mining Company and bought the old Spanish grant of 45,000 acres, near Riverside, on which the tin occurred. A smelter was erected and several tons of tin made and exhibited at San Francisco in 1869. The property, however, appearing to be valuable, litigation as to title arose and this dragged its weary way along until terminated in 1888 by a decision of the United States Supreme Court confirming the mining company in its possession. In the meantime, the mines had been idle. In August 1890 the property was sold to a British Corporation, the San Jacinto Estate Ltd. This company erected elaborate and expensive offices and works but only developed the mine to a depth of 150 ft. In all about 1100 ft. of development was done, and about 6000 tons of ore treated. The average recovery must have been about 2% of metal, and up to the closing of the mine in September 1892, 269,000 lb. of pig tin, sold for $56,000, had been won after an expenditure of $800,000, of which $450,000 was paid for the property. The geology of the district is similar to that of Cornwall. The veins are in granite and on the property there are also quartzite, slate, and quartz-porphyry dikes. About 50 veins were found but only one was worked. This, the Cajalco, is well defined and of good size.

While it is regarded as an unfavourable indication that the gulches and ravines show no stream tin, on the whole it seems entirely improbable that no more tin is present than was mined in the year or more that the mines were actively worked.

The most famous attempt to develop tin in the United States was made in the Black Hills of South Dakota, and despite the ill odour that surrounds this venture the names of two men well known in Cornwall stand out with distinction and honour. It was Mr. Richard Pearce, then manager of the pioneer copper smelter at Black Hawk, Colorado, who in 1879 first recognized the presence of tin in sand sent him from South Dakota, and it was Captain Josiah Thomas who was finally called in to examine and report on the badly bungled enterprise, and who first set the facts straight for the deluded stockholders. The Black Hills form an isolated range of mountains rising out of the great plains far in advance of the main Rocky Mountain range. Their core is a great mass of granite which is intrusive into the ancient phyllites and schists that underlie the later sediments, now outcropping in concentric rings around the hills. In connection with the intrusion of the granite there has been a remarkable development of rare minerals. Mr. Victor Ziegler, of the South Dakota School of Mines, has listed 105, of which 27 are of actual or probable economic importance. Near Harney Peak in 1883 the tin ore first noted by Mr. Pearce was found in place by following up the stream-tin in gulches. The material seemed to be widespread, and in 1887 a British company, capitalized at £2,000,000, was formed to exploit the enterprise. The representations made were, however, so extravagant that the matter was looked at askance. Working capital to the extent of £300,000 was raised, and spent chiefly on treatment plant, but the amount of underground work accomplished was very small. Such methods pre-dispose one to credit the widely prevalent stories of mismanagement and extravagance. It is said that 5000 tons of material milled showed an average content of ¼% tin. When Captain Thomas examined the property in 1892, he found about 90,000 tons of ore developed averaging about 40 lb. of black tin per ton, and he regarded certain of the claims as distinctly promising. The company soon got into difficulties, and Dr. A. R. Ledoux was put in charge as receiver, an excellent choice, though he was hampered by the fact that he was not permitted to spend any money on the properties. In 1909 the property passed to the Pahasa Tin Company, the shafts were pumped out, and the faces sampled by Dr. Ledoux. While his report has not been published it is said that he found 1% tin over faces 18 in. to 4 ft. wide. Many of the claims had lapsed, and on the whole it was held that the property did not justify working on the scale required by the equipment and capitalization of the company. The mill has accordingly been dismantled. On the estate there are a number of veins that would undoubtedly be worked if a custom dressing works or some local market for ore were to be had. In 1910 a much less ambitious attempt was made to develop a tin mine in the northern hills many miles from Harney Peak. That tin occurs here over a wide area extending into Wyoming is certain, but it is difficult to develop a pioneer enterprise of this nature 16 miles from a railway and in rough country. Little is known of this enterprise, but considerable bodies of ore, assaying ½% metallic tin, are present.

Subsequent to the South Dakota attempt to mine tin an effort was made to develop the veins in the Franklin Mountains within sight of El Paso, Texas. As usual these are small veins in granite near a contact with sediments. Two attempts have been made to mine them, the most recent about three years ago. A dry concentrating mill of 50 tons daily capacity was built and a small furnace erected. In 1911, 4 tons of metallic tin was shipped. An engineer who examined the enterprise that year considered the chances of finding a mine to be excellent, but the capital of the company having been all spent on works, in an effort to make the property productive from the first, the project came to grief as soon as the ore in sight at the surface was exhausted. Tin has been produced near Spokane, Washington, and occurs widely, but for the present is not known in quantities of economic importance at many places. While tin has been found in the Southern Appalachian Mountains from Maine to Alabama, and in 1880 the Maine Tin Mining Co. mined ore at Winslow, the most promising localities are further south. In Virginia tin occurs at a number of points and various efforts have been made to develop mines. Ore yielding 3½% metallic tin has been mined though only a low-grade concentrate was made owing to the admixture of arsenical pyrite. Near 'Natural Bridge' is an extensive area capable of yielding 20 lb. per ton (of 2000 lb.) in mill tests, but unfortunately title to the ground is in such a defective condition that no one has ever been able to clear it and so a good opportunity remains unavailable.

In the Carolinas in the King's Mountain region an intrusive granite cuts schists, slates, and limestones, and metamorphism has occurred on a wide scale. There is here a belt of pegmatite, roughly parallel to the mountain, and varying from a few feet to 600 in width and in which tin occurs. The belt is 35 miles long and there are three mines, the Ross, Jones, and Faries, each of which has shipped tin concentrate in some quantity. The district was examined about 30 years ago for Phelps Dodge & Co., and it was determined that from a large area ore yielding 15 lb. of tin per ton could be obtained. As the average price of tin in New York then was about 20 cents per pound with no certainty that it would not go lower, the enterprise was abandoned. At the present price of 37 cents the matter would evidently stand on a different basis. It is worth noting that since the original decision was made there have only been five years when the New York price has been below the standard then set, while the average for the 30 years ending in 1913 was 26·41, 30% above the basis then taken—excluding 1914 and 1915, years of abnormally high metal prices.

In Alaska tin has been mined in two areas and found in several more. At Cape York, about 110 miles north of Nome, a small dredge has been operating for three seasons. The ground yields well, but is limited in extent. Tin occurs over a considerable area and there are excellent prospects of making at least two small lode mines. Owing to the shortness of the season through which work is possible, a large enterprise based upon milling low-grade ore does not seem possible. Near Manley's Hot Springs in the interior tin has also been mined but as yet only in small quantity. In the great stretch of country known as Alaska he would be a bold man who would predict what will and what will not be found, but for the present no tin mining region of first importance has been discovered.

While orebodies do not change, conditions do, and it is in changing conditions that one is permitted to see most hope for the tin industry. The world has a growing appetite for tin and new supplies have not been found in ratio to new uses for the metal. Neither has substitution served to keep down the price. The only result that is possible is an increase in price sufficient to permit the working of leaner ores. Since 1899 the London price has not fallen below £100. Since 1881 it has not been below £90, save in the years 1893 to 1898 inclusive during one of the world's great business depressions when, broadly speaking, no money was made in any industry. Taking New York prices in cents per pound, as more appropriate to the present discussion, they will be seen to show a consistent increase through the last quarter of a century save for the five years of the business depression already noted. A metal that sells above normal for four-fifths of the time and which shows a fairly steady increase in price, is a good one on which to found an enterprise. It has already been noted that in Virginia and the Southern Appalachians there are deposits that can yield 15 or 20 lb. of metallic tin per ton. In the Black Hills, Mr. W. R. Ingalls, who has managed tin mining enterprises, expresses the opinion that there are large bodies of ore that can be made to yield 10 lb. per ton. At the average price for the past 30 years, this gives the following gross values to the ore of the three areas, \$5·20, \$3·90, and \$2·60. At the average for 10 years, excluding 1914, the figures would be \$6·94, \$5·13, and \$3·42. These amounts are considerably above the gross value of lead and copper ores now being worked in many parts of the United States. The average price per pound for Lake Copper for the ten years ending with 1913 was 15·10 cents, for electrolytic it was 14·95, and for tin 34·71. The mining conditions and recovery remaining the same therefore, it would have been possible in that period to have worked a tin mine in the United States in which the ore was less than one half as rich as that of the copper mines. The Michigan copper mines of recent years have averaged 20¼ lb. per ton of ore (2000 lb.) according to the testimony of Mr. James B. MacNaughton, general manager for the Calumet & Hecla. This would correspond to 10 lb. of tin, both figures being based upon recovery, since in Michigan the percentage of copper in the rock is not known. Like Cornish tin mines they have taken no account of chemical assay of the rock in place. The cost per ton was given by Mr. MacNaughton at \$1·86 per ton, a trifle less than 8s. As a matter of fact they do even better, as the conglomerate lode of the Calumet & Hecla averages now but 15·85 lb. per ton. It is to be remembered that the Michigan mines are deep and expensive to work. While bodies of ore as much as 25 ft. wide are mined, there are many narrow faces, and the comparison is closer than at first sight might appear. Copper in Michigan occurs as the native metal and in stating the grade of the ore no account is taken of milling losses. In the west, in the so-called porphyry mines, the copper occurs as a sulphide and the grade of ore quoted refers to the assay of the crude. As the recovery is about 65 to 70% the difference is ample to cover any probable loss in treating tin ore, and while the western copper mines derive an incidental revenue of a few cents per ton from the gold and silver found with the copper, a similar return might be expected from the tungsten and rare minerals that occur with tin. The comparison is not therefore an unfair one. There have been few mining industries that have changed more completely in recent years than copper mining in the Western United States. The introduction of adequate capital for preliminary work and the construction of enormous plants have effected a complete revolution and thousands of tons of what for years was waste rock now go daily to the mills. The Nevada Consolidated has operated for months on ore containing but 1% of copper to the ton, and a number of properties work regularly on ore ranging from 1% to 2%. The Ray Consolidated, which mines by underground methods and therefore must face higher cost, treated last year ore averaging 2·21% copper. The recovery was 67·88%, the total cost $2·28 per ton, and the amount milled 2,427,700 tons. Allowing for the higher price of the metal and equal tailing losses, a tin property worked on the same scale would have needed to yield only ore averaging a trifle over 1%. These low costs of operation are not singular to copper mining. The Homestake gold mine in the same general area as one of the known tin occurrences treated 1,587,000 tons at a total cost of $2·91 per ton (12s.), of which nearly half was the underground mining cost. In Missouri lead mines are regularly worked at an operating charge of $1·20 to $1·25 per ton, equivalent to about five shillings, and in Alaska the Douglas Island mines of the Treadwell group mine at great depths with a total cost of $1·40. On the main land gold mines are now being opened on a cost basis of 80 cents (3s. 4d.) per ton of 2000 lb. On this basis a tin ore, if occurring in a body of suitable size, and containing 10 to 20 lb. metallic tin per short ton (equivalent roughly to 8 to 15 lb. black tin per long ton) might conceivably be worked in the United States. Probably a few such bodies of ore occur and in time they will, perhaps, be worked. The difficulties are great but by no means insuperable, and, while to one familiar with the peculiar difficulties of tin mining and dressing the prospects may not appear brilliant, they are not too discouraging to warrant the attempt.

Federated Malay States.—The report of the Mines Department of the Federated Malay States for 1914 has just been published. It has been prepared by W. Eyre Kenny, the Senior Warden, and it gives details of output and of the administration of the Mining Regulations. The figures for the output of tin are based on the exports, for practically no smelting is done within the States. For the benefit of readers who have incomplete knowledge of the Malay Peninsula, we may explain that the Federated States comprise Perak, Selangor, Negri Sembilan, and Pahang. Another group of states in the peninsula is called the Straits Settlements and includes the states of Singapore, Malacca, and Penang. The smelting of tin concentrate is done in Singapore and Penang. The calculated outputs for 1914 in tons of contained metallic tin were: Perak 28,557 long tons, Selangor 15,103 tons, Negri Sembilan 1697 tons, Pahang 3685 tons, total 49,042 tons. The total output during 1913 was 50,127 tons, the only state showing an increase being Pahang. Seventy-six per cent. of the output was won at mines under Chinese ownership and management.

The output of wolfram concentrate was as follows: Perak 36 tons, Selangor 193 tons, Negri Sembilan 3 tons, total 232 tons. During the year 1913 the output was 206 tons. The wolframite occurs in conjunction with cassiterite and it is separated from the tin concentrate at works situated at Kuala Lumpur in Selangor, and at Ipoh, Perak. These works also treat mined concentrate from other states of the Malay Peninsula and the wolfram concentrate produced from these sources is returned at 163 tons. A small amount of scheelite concentrate was also produced, the figures being: Perak 5 tons, Selangor 22 tons, Negri Sembilan 1 ton, total 28 tons.

The production of gold continued at about the same level as in the two previous years, the figures being Perak 935 standard ounces, Negri Sembilan 64 oz., Pahang 13,273 oz., total 14,272 oz., worth £55,304. The chief producer is the Raub mine, in the state of Pahang; in fact practically the whole of the Pahang output comes from this mine. The mine is owned and worked by a Queensland company. Coal mining will commence in all probability during the current year, or as soon as railway connection is made with the property of the Malayan Collieries Limited.

SAMPLING AN ERRATIC OREBODY

By L. A. PARSONS.

Estimating the value of an orebody in which the ore is distributed according to no ascertainable rule involves problems which are much in dispute. To those who would discard mine sampling for a mill test it is suggested that the large sample sent to the mill may be entirely unrepresentative. The latter is the critical factor and it is believed that widespread careful hand work gives a more representative sample than does mining for a mill test. Confirmatory results are quoted.

IN your issue of February last there appeared an interesting article by Mr. Morton Webber on 'Latent Errors in Mine Sampling.' In this article Mr. Webber classifies the type of erratic ore occurrence, in which the valuable mineral occurs in bunches, under the general heading 'Mines where sampling is no use,' and recommends the mill test as the only reliable method of valuing such mines. To quote: "The only method of reliable valuation in a deposit of this type would be based on authentic record of past yield, in combination with competently selected representative shipments of the remaining ore."

With this I cannot altogether agree. Authentic record of past yield is of the utmost value, but I believe that this is much better studied in combination with proper sampling than with mill tests. I do not refer to those tests made to determine metallurgical treatment, or to those made over an extended period of time to confirm sampling results, and which amount to operating the mine under option, but to the mill tests designed to take the place of sampling because considered more reliable—"representative shipments." These practically amount to large samples, and my contention is that they are no more justified in an erratic mine than in a uniform one; rather less so, if anything, for the chances of error are greater, and the safety resulting from averaging a large number of samples is needed. Before discussing this further, I shall describe briefly the methods used and results obtained at one mine of this type that I had the privilege of sampling and studying in great detail for a period of two years. This mine forms an excellent illustration of this type of deposit, and of some of the principles that affect the accuracy of the results when sampling by the ordinary hammer-and-moil method.

The formation at the mine in question consisted of highly metamorphosed sediments and igneous rocks, carrying irregularly scattered lenses of gold-bearing quartz ranging from almost microscopic size to several feet in thickness. These schists without quartz would assay from nil to about 3 dwt., averaging less than 1 dwt., and the quartz from nil to several hundred pennyweight. Frequently the gold was in coarse flakes, making most brilliant showings. The quartz stringers, in combination with the richer portion of the schists, formed erratic ore zones separated by comparatively large zones of waste, and showed no consistency, taken either singly or in groups of any size. There was no habit or condition that could be discovered affecting the sudden changes from spectacular ore to practically barren waste. Mr. Webber mentions levels 30 ft. apart giving erratic results. I remember one cross-cut, sampled by a continuous channel along each wall, of which, over a distance of 200 ft., one wall averaged one-third of the other. These walls were perhaps 5 ft. apart. The troublesome nature of the ore was evidenced wherever samples were used: in the assay office, duplicates would not check at all unless ground to 200-mesh; in the mill, samples of battery pulp over a month would not check amalgam plus cyanide heads. The amount of underground development was hardly greater than would have been necessary to stope a uniform deposit of the same size, and very different from the network that Mr. Webber states to be necessary for deposits of this type. Levels about 80 ft. apart, and drifts and cross-cuts about 150 ft. and 75 ft., with of course local modifications for all of these, is not a large development proportion. In fact, per ton of ore blocked, it is small. According to my opinion these conditions formed as extreme an example of Mr. Webber's classification and as difficult a problem as one would be likely to run across. And yet this mine was sampled and ore blocked out, and is being sampled today. The results are of the utmost value, both to the men financing the property and to the management planning exploration and development work. It *had* to be sampled. There was no other method of working it intelligently.

The method of sampling did not differ in any essential from that in general use by a large number of engineers, so a brief description of this should suffice to make it clear.

As neither the quartz stringers nor the ore zones had any definite trend, samples could have been taken in almost any direction. For ease in sampling all channels were cut horizontally about breast high along the sides of the drifts and cross-cuts. (A distinction was made between drifts and cross-cuts according to their relations to the stopes, but structurally they were the same). Both sides were sampled, as so little was known about the deposit at first that all the information obtainable was needed. These channels were the usual kind cut with a hammer and moil, and yielded about 1·5 lb. per ft. The rock surface was first cleaned with a scrubbing brush, and the channel, about 3½ in. wide, outlined with chalk. The samples were caught in an ordinary iron meat pan about 12 by 18 by 2 in. This was more easily cleaned than a candle box or canvas, and made possible a more detailed examination of the sample as it was cut. In the low-grade or barren schists, samples were taken up to 60 in. long, but in ground which was apparently rich no sample was taken more than 30 in. long. This was in uniform rock. With every change in the character of the ground the sample was bagged and a new one started. In small quartz stringers this would frequently give samples not over 3 in. long. In such cases the size of the channel was always increased to make the total weight of sample not less than 2 lb. Quartz containing the coarsest gold was not avoided in any way, but everything within the outline taken as mechanically as possible. Any adjustment necessary was made in the office afterward.

The question of high assays was of course always coming up. The first step in their treatment was re-sampling. All places yielding erratic assays were re-sampled in the bottom of the original channel. The decision as to whether an assay was erratic or not did not depend so much upon its tenor as upon that of its neighbours. An assay of 10 dwt. in one place might mean a re-sample and in another one of 50 dwt. be let go. The two or three assays of the same place thus obtained were averaged and the resultant tenor entered in the records with no reduction. At the times of calculating the ore reserves, when studying the relation of each sample to all the others, it occasionally seemed advisable to cut down an assay to a tenor more consistent with the apparent structural importance of the rich spot yielding the sample. In addition to this, an arbitrary high figure of 500 dwt. was adopted, to which all assays above that figure were reduced. There were so few assays higher than 500 dwt. that it was thought they would affect the average out of proportion to the probabilities of their being duplicated in the interior of the blocks. These two causes combined affected a negligible proportion of the assays—probably less than one tenth of one per cent.—and it is merely to show the methods of work that they are mentioned here.

In connection with the re-sampling an interesting fact was observed: the majority of times the re-sample gave a lower result than the original. I think the reason for this is clear. The occurrences of rich specimen ore were on the average so small that it was probable a large proportion of such an occurrence would be cut away by the offending sample. Similarly, I have no doubt that re-samples of the promising looking ground which had returned low assays would have given on the average higher results than the original. The averaging of the two assays thus introduced a slight factor of safety.

It will be evident from what I have said regarding the size of the rich zones that any attempt to mine them separately would have been absurd. The only feasible project was to take all within the mineralized zone. Therefore, in valuing ore blocked by the sampling results, the ground was considered as a low-grade mass, and no attempt was made to segregate tonnages for the small rich zones. This resulted in a method much the same as would have been used for a more uniform deposit. After the few adjustments of the high assays had been made as described above, the ground was divided into areas as indicated by the horizontal workings, and each area valued by dividing the total inch-pennyweights of the periphery, high and low alike, by the total sample length in inches. The blocks between levels were valued by weighting the tenor at each level by the area blocked. Rises in general were used merely to prove continuity of ore, although occasionally their tenor was averaged with that of the levels. The final result was adjusted according to knowledge of the mine. Bore-hole results were of great assistance in this, although used entirely for information as to continuity and not for obtaining the tenor; and as mining progressed the samples from the development were supplemented by moil samples from the stopes. The latter were averaged with the development samples when practicable.

The results of this method were highly gratifying. For a period of two years, the tenor of the total ore mined as indicated by moil samples, when compared to amalgam plus cyanide heads for a quarter of a million tons milled, indicated a sampling factor of 112%. I regret that I am not at liberty to give figures in greater detail, but I think these will illustrate my point. It may be contended that these results indicate nothing, because the work was done by the mine staff, who brought their intimate knowledge of the mine to the final interpretation of the results. This was undoubtedly a factor, but it was a factor dependent upon experience and not upon any lessening of the difficulty of the work. Any independent engineer with sufficient experience could have arrived at the same results. In fact, in the early history of the mine, an examination was made by an independent engineer who predicted almost exactly what would occur.

The above example illustrates certain principles that I think can be applied in a greater or less degree when sampling any erratic deposit. Although it is an axiom in mine valuation that every mine must be judged on its merits, according to the experience of the examining engineer, and no hard and fast rules can be laid down, still I think these principles form a good foundation for working, and are certainly of more general application than considering sampling utterly unreliable and not using it for the data that it can give. I shall try to state these principles as I see them, omitting the actual manipulation of the sample, precautions against the increased danger of salting oneself, and details of that nature as being sufficiently taken up in the short description of actual practice above.

How to average high assays is apparently the question that bothers the majority of men most. There is a vast difference between the occasional high assay in ore of essentially uniform tenor, and the condition where the recurrence of very high erratic assays makes up almost the entire value of the ore. In the latter case I believe the result will in general be nearer the truth if high assays are reduced very sparingly, and then only for extremely good reason ; assuming of course that there is sufficient development work to allow the law of averages to work. A high assay represents the tenor at a spot sampled. Whether that ore extends to the next development working or not is immaterial ; the assumption is that it will be duplicated by other small patches within the blocks. Erratic and variable though the rich intersections may be over short distances or in workings close together, when taken over sufficient length of workings the average will represent, within the limits of error to be decided by the engineer, what the entire mass of ore blocked out will yield. The theory is exactly the same as that which governs uniform deposits, but engineers seem to fear to apply it to the type under discussion. The high assays in the mine I have described were not sufficiently frequent to consider them the usual thing—in fact quite distressingly infrequent at times—and yet an attempt to cut them down by any of the well vouched for methods would have resulted in indicating on paper merely a large mass of waste. I am not at all sure, from the mine's subsequent history, that even the slightest reductions I described were justified. When sampling such a deposit, samples should be cut impartially through rich and poor alike, the mine studied structurally, and when the assays are in, all the information correlated before making up the averages. Then if for any reason some assays should be reduced, well and good ; but an assay should not be reduced without knowing why it is done, merely on account of some vague idea that it is good practice and playing safe.

Two much discussed methods for increasing the accuracy of the results on such a deposit are decreasing the sampling interval and cutting the ore into small blocks. I do not believe that either of these is exactly the remedy. What is desired in sampling is to obtain sections of the orebody which are representative of its tenor as a whole. It is obvious that if the development openings are not thus representative, no amount of close sampling will increase the accuracy of the final result ; it will merely increase the accuracy of the tenor assigned to those development workings. Therefore the sampling interval need only be small enough to give the tenor of the workings to a degree of accuracy consistent with their representation of the mine as a whole. Decreasing the interval below this point adds nothing. As for cutting the ore into small blocks, this will increase the accuracy of the estimate for each block, and therefore for the entire developed portion of the mine ; but is that exactly what we are after ? In most cases the maximum amount of development that can be done is more or less a fixed quantity ; compressor capacity, shaft or tunnel capacity, and cost limitations all contribute to this. The development that is used to cut already developed ore into smaller blocks is not exploring the mine for extension ; and it is the results of this exploration that more than compensate the engineer for the lessened accuracy of each single block. To put it differently: the smaller the blocks, the more nearly accurate is the tenor assigned to the ore thus outlined; but if we grant that this ore is only a small portion of the whole, then the larger the blocks, that is, the more the development is spread out, the more representative of the whole this development will be. There must be enough samples for the law of averages to work, for the high assays to represent what will, on the average, be found in the interiors of the blocks. As shown above, obtaining this number by decreasing the sampling interval avails nothing; the samples must be from representative development. Therefore the accuracy of the result when sampling an erratic mine depends most upon the total amount of development in the ore, not the amount per ton, and the blocks need not be smaller than would be required for mining.

The question of valuing by sampling a mine where the values are like "plums in a pudding," as it has been so aptly phrased, compared to the mine where values are evenly distributed, is not one of impossibility, but of relative accuracy. The error will be larger than with a uniform deposit, but as long as the probable limits of error are known, the results will often be as useful as if they were more accurate. Within these limits of error, by working according to the principles outlined above, ore can be blocked out as in the uniform deposit. However bad conditions may be, they will affect the mill test more than they will sampling. Certainly I know of no method of making a mill test on the mine I have described that would have yielded information at all comparable for accuracy with that obtained by sampling. Two years' actual production gave no indication of what the tenor of the mine as a whole would be; yet the current sampling indicated it after the mill had been running six months. It was over two years after a certain tenor had been predicted by sampling before the mill results began to conform to that tenor. The reason for this is perfectly obvious: the stoping was not done from representative places. *Representative*—that is the crucial point. Unless a man is clairvoyant, there is no method of obtaining representative shipments. And if he could select the proper places, a few holes one way or the other by the machine men would entirely alter the tenor of the test. It comes right down to the old question of a few very large samples versus an enormous number of small ones—a question that has been many times discussed. Obviously, I am an advocate of small samples. It is hard for me to see any advantage in a few large ones that can compensate for the effect of averaging a quantity of small ones taken with machine-like impartiality all over the mine.

It seems to me that often such stress is laid upon great precision in mine sampling and valuation that sight is lost of larger issues that are more vital. Some of these have been outlined above, such as spending time and money on work whose sole object is to gain greater precision in the tenor that is assigned to the ore, rather than spending it on exploratory work that would give much needed information as to the future of the mine. And certainly this striving for great precision has no more serious consequences than when it prevents an engineer from giving any opinion as to the value of a mine, because its character is such that the results cannot be accurate within the limits of error he has assigned himself. The erratic mine is the most difficult problem the examining engineer has to face, but that does not alter the fact that it must, upon occasion, be faced. To reduce high assays sweepingly for no reason except custom, or to refuse to place any reliance upon sampling through an excess of conservatism, is to sidestep the issue. The best opinion obtainable on the value of this type of mine is that honestly given by an experienced engineer without undue conservatism or optimism, after an adequate study of the mine structurally, a thorough sampling, and an analysis and correlation of the assay returns with the structural data obtained, and past yield if obtainable. To this opinion an engineer's clients are entitled.

Radium is now being produced on a practical scale by the United States Bureau of Mines, acting in association with the National Radium Institute. The Institute secured ten claims containing deposits of carnotite in Colorado from the Crucible Steel Company. Carnotite contains both uranium and vanadium oxides, and the Colorado deposits were developed originally for the vanadium content. We gave some particulars of the deposits and the method of extracting the vanadium and uranium compounds in our issue of November 1910. At the treatment plant near Denver the total cost of producing 1 gramme of radium metal as bromide during the months of March, April, and May of this year was $36,050, and the selling rate has been from $120,000 to $160,000.

DISCUSSION

Helping the Empire.

[The letter which we reproduce below was prepared originally for private circulation. It covers a matter, however, of such vital interest to so large a number of our readers, that with Mr. Curle's permission we print it entire. Mr. Curle sets us all a good example. Having giving his services, he also pledges his income. It is a fact that cannot be too often pointed out that this war can only be won by sacrifice on the part of those who stay at home as well as those who go to the front.—EDITOR.]

Dear Sir—The war has already lasted for a year. The main fact which has come to light in it is the military and economic strength of Germany, and her organization; and we find her, at the end of the period, to be firmly holding her own.

Intelligent people in Britain now realize what their nation is up against. Throwing off that under-estimation of the enemy, and that flattering unction from their souls which has done so much harm, they now understand that the war can easily last for another year, and quite possibly for a third year, the period estimated long ago by Lord Kitchener.

Germany is now known to be self-supporting in the food staples. It is reasonably to be inferred, after a close study of the question, that her government can lay its hands on all the raw material required for a long time to come, while her allies, Austria and Turkey, are more or less provided for, and not a serious drain upon her. In other words, Germany, because of her long preparation, is self-contained in this war; her money circulates within her own borders, and a trade boom is at this moment in progress there. In her state bank lies a reserve of 120 millions sterling in gold; while her people, imbued with a certainty of victory, accept in the meanwhile a paper currency, and ask the Minister of Finance no questions. In short, neither in men nor materials is Germany seriously embarrassed, while her 68 millions of people stand behind her, confident, organized, and loyal to the State.

The other vital fact of the war for us is Great Britain's immense expenditure upon it. This is now well over three millions a day, and all the time increasing. It is just about £40 a second. If these vast sums were circulating in Great Britain, as Germany's war expenditure is circulating in Germany, we might view the outlook with some complacency. But they are not. We buy 60% of our food from overseas, much of it from foreign countries. In addition, we are now buying war material abroad wholesale, and at war prices. Thirdly, there is the great drain upon us through our allies. We are financing Belgium, Servia, Montenegro, and to a considerable extent Russia. A few months hence we are likely to be financing Italy. It is a burden we cheerfully take up, recognizing the great help our allies are rendering; but the burden will most certainly become greater, and has to be faced. To this tale of our vanishing capital must be added the loss of our merchant ships by submarines. To date the loss is over 100 ships, the value of which, together with the cargoes, amounts to millions of pounds.

Finally, the war has so disorganized the trade of the world, that many states, also railways and enterprises abroad owned by us have defaulted, and have ceased to pay their dividends. The loss to us under this head is very great, and ever increasing.

Against this so great foreign expenditure and general loss of our capital, we have our national exports. But these are seen to be greatly lowered by the war, and in no real measure set off the balance on the other side. It is probably near the mark to say that, while German capital is on the whole circling round and round in Germany, British capital is going out of the country and being lost in other ways at the rate of two millions sterling a day: and is leaving us that much weaker to carry on the war.

The position is very serious indeed. The vast war expenditure of this country, the dead loss of so much of its capital, cannot have escaped the notice of the German Government; and it is more than likely that they are setting themselves to outlast us in economic endurance, and to bleed us financially white. They have behind them a loyal, an almost fanatic nation, who will stop at no financial sacrifice. If the word goes forth that the issue with England is to be one of endurance, the people will respond. If a fifth, if even a third of the national income is demanded for the continuance of the war, and the wearing of us out, that third will be provided.

And they will figure upon us ourselves. We 45 millions of British are unorganized, we are undisciplined. With us, among large sections of the people, it is the individual first and the State second. As we stand to-day we have not the loyalty of the Germans, and the Germans know it.

Let it be granted that we are sound at heart. Nevertheless we are ignorant, and we are terribly thriftless. To bring us back to real loyalty to our country, to organize us to thrift, and to rival German self-denial by our own, is going to take long, is going to call for all the energy of our best men and women. It will not be done by speeches, nor by writing. It will only be effected personally, man by man, woman by woman, by example, by persistence, by patience, and by personal propagation from the lips of those who know our danger.

Our Government is provided with funds till the end of this year. For the year 1916, if war continues, the Government, outside of the ordinary budget, will need another 1000 millions. Of this vast sum the banks, the great companies, the capitalists may be able to furnish one-half; but there is every reason to think that the people in general, in order to win the war, will be called upon to provide the remainder out of their current income. That this remainder, nearly two millions a day, should be loaned to the State voluntarily is absolutely necessary for England's soul. It can be done. But it needs immense enlightenment, a continuing loyalty, a national organization of self-denial, and an entering upon the work of education at once. Organization is a wonderful thing. A penny a day saved by the whole nation would amount to 68 millions a year. Ten per cent. saved out of the people's income would amount to several hundred millions, and we might all, it seems to me, average better than ten per cent.

It must begin at the top. The heads of the nation, all those in authority, all the well-to-do must be in the scheme. Their position will not be honorary. They will pledge themselves, one and all, upon their honour, to save a part of their incomes, and invest such part in the war loans of next year, and the whole nation will be organized, upon its honour, to follow the example. We must be prepared for ignorance, for apathy, for selfishness; but carrying on the propaganda with fullest energy, taking the people man by man, woman by woman, gradually overcoming inertia, and placing each man and woman won over upon their honour, I have no doubt whatever of a splendid success. The five shilling voucher is beyond the reach of no one. In the general organization it will become a very powerful instrument indeed. We should look forward to the time when many millions of these are applied for by the people, rich and poor, each week.

And I rely for success upon the women. Tens of thousands of our women, eager to serve without pay, deeply desiring to give something to the State, have felt their futility in this war. But let each housewife in Britain now take note! Let every tactful woman, every woman of means, every mother or wife or sister in this country hear at last the great thing she can do! Next year, and perhaps the year after, the fate of England will lie, to a great extent, in the women's hands. The nation must save. The women—the housewives—must see to it that the nation does save. A great and splendid part for them in the war is now opening.

The women will be the chief medium in our organization, but not the only one. There are the Churches, the Salvation Army, the lodges, the trades unions, the savings banks, the municipalities, the County Councils: and to advertise the movement there is the press. There is the support of the rich, and the example of the great; but upon the women of Britain we shall do well to rely the most of all.

Again I say this organization will be no easy thing. It is too personal for that, and like charity will begin at home. The people to be hardest hit will be precisely you and I—I who write this, and you who read it. Schemes of this nature, as a matter of fact, are always drawn up for other people, usually for the poor; but in this war you and I have come up against reality at last. In it we happen to see farther than the people in general, and we are in honour bound to set the lead with our own money.

So be it then—popular or not. I, for my part, pledge my honour to place half my income in the coming war loans, and for the duration of the war. From you, who may have many more demands upon you, I ask no such proportion; but if I have stated my case to satisfy your judgment, I ask you to place yourself upon your honour, and further the scheme with such savings and such energy as you can command.

Finally, whether the war lasts one month more, or it lasts two years more, the scheme will stand upon its own merits. National economy, for an ideal, will elevate and purify the nation. Trade will be damped down, it is true, while luxuries and imported goods will suffer more or less ; but with the continued immense disbursements of the Government there can be nothing like dislocation. An early result should be, with diminishing demand, the return of food prices to normal, a consummation greatly to be desired. The national nest egg laid by will prove of the utmost economic value in the hard times to come. While the steady flow of the nation's savings into the Treasury will go far to win, if it does not of itself really and truly win, this war of exhaustion.

I am going to the front soon. I leave this scheme to my family and my friends, in the confident hope that their united sincerity and energy will launch it among an ever-widening circle of loyal helpers. But it must begin with the well-to-do.

J. H. CURLE.

London, August 4.

Tin Dressing in Bolivia.

The Editor :

Sir—I am indebted to Mr. Harold Allman Lewis for the information he affords, and no longer wonder why Bolivian tin shipments are of such comparatively low grade.

Mr. Lewis' controversial methods remind me of those of the miller who abashed the complaining farmer by accusing him of using last year's ready reckoner. While we practically agree on smelter's charges, he takes tin at £150 (in September last!) and realization charges on a 60% lot at about £30, as against my figures of £130 a ton for metal, and £36 (his own estimate) for realization, and oracularly pronounces that the result, though modified, is the same, and the exact opposite of that arrived at by me using arithmetic alone.

If he cares to re-calculate the result of his re-dressing test, taking the figures I originally used as a basis, he will find that the operation in which he abstracted a tailing going 31·9% metal left a profit so long as his re-buddling costs did not exceed 5s. per ton on the feed. On the actual figures he now uses, 25% roundly is the most the tailing can go without a monetary loss, and it is difficult to see why, in a test that was evidently run under special control, and where this figure must have been known beforehand by calculation from the assumed data, a tailing averaging 31·9% should have been allowed. As there were 8 quintales of this from a feed of 30 there was presumably some smaller quantity of real tailing. Except from the point of reducing transport as much as possible, it is not desirable that the tailing should be allowed to go 25% as a whole. The ring on the buddle corresponding to this assay should be found, when everything inside is heads, and everything outside tailing. The tailing will not then average 25%, but something less, but the heads will contain nothing separated by the buddling and going less than 25%, and the parcel will have its maximum value. I decline to agree with Mr. Lewis that concentrate carrying only 4% silica is clean so far as mechanical tin-dressing goes. The millman may think so, but the accountant won't. I define clean concentrate (for shipment) as that from which nothing is commercially separable that is too low-grade to pay its own realization charges.

I hardly think that it is necessary to labour the point that the inclusion in shipping ore of material which is commercially separable, but not rich enough to pay its own fare, is indefensible, yet its importance seems to be frequently overlooked even in remote districts where realization costs are so high, and transport a real difficulty. It seems repugnant to most people's feelings to make richer tailing, and smaller shipments, and metallurgy 'by guess or by gosh' still lingers on. The three features which make it specially necessary that Bolivian operators should observe it are :

1. That tin sold in this manner benefits only the tax-collector, the transport people, and the smelter, and positively injures the producer, as it increases the supply and brings down prices.

2. That such tin, instead of being 'given away'—to adopt the expression Mr. Lewis attributes to me—remains on the mine, and may some day become a valuable asset under improved economic or metallurgical conditions.

3. That the amount of transport it is necessary to provide is much reduced.

This last is a factor which I think Mr. Lewis should appreciate.

R. T. HANCOCK.

Jemaa, Northern Nigeria, June 27.

Borax.—The production of crude borate in California during 1914 amounted to 62,400 short tons as compared with 58,051 tons the previous year. The largest individual producer was the Pacific Coast Borax Co., whose Lila C. mine is in Death valley. The production of borate in Chile is approximately equal to that of California. Turkey also has important mines, but the outlet for their produce is barred at present.

SPECIAL CORRESPONDENCE

NORTHERN RHODESIA.

EARLY last December a dozen of us mining men left our billets on the Union Minière copper properties in the Katanga country to join the Northern Rhodesian Rifles then mobilizing at Broken Hill for active service on the German East Africa border. Detraining at Kashetu, we had a strenuous march in the rains to a border station near Abercorn, and after a short stay, on to Fife, a long trek of 600 miles. Here we have been the past four months engaged in patrol work along a stretch of the border. Our force has had four or five scraps, losing three and a few wounded, but I will confine myself to the description, from a mining point of view, of the country I have passed through. From Kashetu we travelled in a northeasterly direction, 100 strong with 16 ox-wagons, along the Luapula-Loangwa watershed to avoid the numerous water-courses, to Pika and Kasama, passing about 20 miles to the north of Serenje. I was not at all prepossessed with this part of northeastern Rhodesia as an agricultural country, and its possibilities of mineral deposits do not appear very promising. The predominant rock is sandstone with bosses of intruded quartz and hornblende granite. Near these contacts gold will possibly be found, as it has been in a similar formation southeast of Broken Hill recently. The northern part of this territory consists mostly of flat-lying red sandstones (felspathic) mostly free from dikes and disturbances over long stretches where exposed. These are probably of Devonian age, and are of the same characteristics as the Kundilungu series of Katanga, Congo Belge, but the whole country is difficult to prospect, and owing to the paucity of outcropping rocks is expensive to work. For these reasons principally, no really systematic prospecting work appears to have been done. The geological conditions to the west of Kasama (where, by the way, 25 Fort Jameson men joined us) are much like Kundilungu, Katanga, where the diamond pipes have forced their way to the surface. The same felspathic sandstone extends northward to the German border and rests generally horizontally on the old Nyasaland granite, which there forms the watershed of the country, extending from the Shirè-Zambesi valley to northwest of Baudouinville on Tanganyika lake. To the east of this immense granite country the mineral prospects appear far more promising, as the old schists and Silurian rocks are found, and are first noticeable at Shupanga, also on the Zambesi at Morumbula Mount, at Shirè-Zambesi junction (where the granite comes in), to east of Mount Melangi, Nyasaland, round the north of Lake Nyasa, and following on to the northeast of this border. On the west side of this granite the sandstone generally lies flat, both in Northern Rhodesia and in the Katanga. I have spent the past 23 years in mining work in Africa, and am now anxious to get into German East Africa and judge of its mining possibilities. From what I have seen and heard, I should say its mineral prospects are encouraging, and that the uplands form also a fine ranching country.

SAN FRANCISCO.

THE EXPOSITION.—The centre of mining interest at present is the Panama-Pacific Exposition. Mining engineers and professors from all parts of the world are daily visitors. Among the recent arrivals we noticed Professor Locke, of the Massachusetts Institute of Technology, who told us that the war had helped his department by so largely increasing the profits of the powder makers that one of them had given a large sum toward a new mining building the total cost of which will be £45,000, two other mining graduates furnishing the balance of the money needed.

The most striking exhibit in the mines building at the Exposition is a column of gilt cubes, each the actual size of the gold produced by the individual country. The Transvaal cube may seem surprisingly large to the average American, but a study of the figures of production shows that there is no error and that the Rand produces about 40% of the world's gold.

Japan is conspicuous among the mineral exhibits by her faculty for artistic arrangement. The specimens of ores, coal, and oil that she shows are not remarkable in themselves, but, piled in their neat bamboo baskets, their clever decorative effect makes the disorderly jumble of minerals from the Western States appear insignificant. The Mitsu Bishi

Co. is the largest exhibitor from Japan; an owner of 15 metal and 8 coal mines, its annual product is valued at £3,700,000.

The model mine into which one descends has the familiar smell of decaying timbers that makes it homelike. Of vivid interest, and of terror to the non-mining visitor, is the explosion that takes place in its depths daily. The victims of the explosion are saved by a rescue crew, which is able to penetrate the deadly gases thanks to the oxygen helmets with which they are capped; skilfully rendered 'first aid' soon enables the sufferers to revive. This rescue work and first aid is becoming popular in all the mining camps of the West. At recent festivities in Butte five teams contested for prizes: these contests are very common and excite as much interest as a football match. During the meeting of the International Engineering Congress, which now numbers 3000 members, there is to be a series of contests between first aid and rescue teams from all over the States. Free instruction is given in this work at the Exposition and also by mine rescue cars sent out by the United States Government for that express purpose.

The Bureau of Mines has, at the Exposition, a large and fully equipped laboratory where experiments and investigations are being carried on; wet methods of working the Tonopah silver ores are being studied; microscopic examination of complex sulphides is another subject under investigation. Practical results are hoped for.

ANTIMONY.—Owing to the great advance in the price of antimony every available deposit on the Pacific Coast is being worked, or is on the verge of working. An antimony smelting company has resumed work in San Francisco, and expects to produce at least sufficient metal for the local demand. If the price of antimony keeps up it is likely that supplies of the oxide ores of Lower California will enter the market.

GOLD.—Among the rich finds of recent years, that of the Cresson Gold Mining Company, Cripple Creek, Colorado, has perhaps been the most remarkable; a small stringer of sulphide was followed into a cave lined with sylvanite. The profit made from the working of the orebody has enabled the company to pay large dividends. For the period January to March £200,000 was paid in dividends, and another dividend of the same amount is expected for the April-June quarter.

ENGELS COPPER.—The 200-ton mill of the Engels mine, Plumas County, California, is noteworthy in being the only mill yet built that uses exclusively flotation. This plant was designed by the engineers of the Minerals Separation company. Flotation is daily attracting increased attention; it is likely to become as fashionable as was the cyanide process twenty years ago. Charles Butters is studying flotation of gold ores, and predicts that it will soon become the rage. His new works among the palms, roses, and oaks of Piedmont, near San Francisco, contain what is perhaps the most complete testing plant in the United States; it is certainly the most pleasantly situated. Mr. Butters is now making exhaustive experiments to determine the suitability of aluminium dust as a precipitant from cyanide solutions; he finds it cheaper than zinc on certain ores.

TORONTO.

PORCUPINE.—The production of the Dome Mines shows a steady increase. The monthly statement for July gives the value of gold produced as $131,928 from the treatment of 28,300 tons of ore, being an average yield of $4·67 per ton. A quarterly dividend of 5% has been declared, requiring a disbursement of $200,000. A new orebody is being developed, which largely increases the ore reserves. It has its apex at the 260-ft. level, and from that depth down to the 560-ft. level will average 100 ft. in width, some of the ore yielding high assays. The shaft is down to 770 ft., and development at that level is beginning. The 4-weekly statement of the Hollinger for the period ended July 15 shows gross profits of $124,222 from the treatment of 25,076 tons of ore, being an average extraction of $9·24 per ton. The working costs were $3·53 per ton milled. In addition, the mine treated 10,652 tons from the Acme mine. During July the McIntyre milled 9410 tons of ore of the average value of $7·89 per ton, the recovery of gold being about $71,600 or 96%. The net profits for the month were $27,600. An extensive orebody has been discovered on the 500-ft. level, containing about $9 per ton gold. The shareholders of the West Dome have ratified the scheme for re-organization proposed by the directors. A new company, entitled the West Dome Consolidated Mines, will be organized, capitalized at $3,000,000. Two-thirds of the stock will be issued to the old shareholders in the proportion of two shares of new for every three of the old stock, and the remaining shares will be sold to provide a fund for development. There is much activity in some of the outlying districts near Porcupine, including Boston Creek and Sesikinika, in both of which localities many claims have recently changed hands, high prices being paid in some cases, and a good deal of development work is being undertaken.

COBALT.—The increase in the price of silver has had a favourable effect on the silver-mining industry, which is becoming more active. The leading mines have resumed bullion shipments, and the market for Cobalt issues is much stronger. Work on several prospects, which had been closed for some time, has been resumed. The Nipissing during July produced silver of an estimated net value of $179,998, of which $99,039 was from high-grade, and $80,959 from low-grade ore. No. 80 shaft has been re-opened, and several cross-cuts are being run to pick up faulted veins, and new ground is being explored from the second level of No. 64 shaft. A vein being mined by open-cut near Peterson Lake shows 2 in. of 3000 oz. ore. The Coniagas is installing a small cyanide plant to re-treat the slime tailing. The concentrate will be treated along with the mine slime, and the precipitate obtained refined at the company's smelter at Thorold, Ontario. The O'Brien has commenced work on their property in the Gillies Limit known as A1, situated on the ridge running south from the McKinley-Darragh. A shaft is being sunk on a strong vein yielding galena with low silver content.

Capitalists from Rochester, New York, have organized the Genesee Mining Co. to take over the old United States Cobalt mine on a 6-year lease. The property has been idle since 1906. The Shamrock, another old-time mine with a complete plant, is being re-opened. The Gould leasehold, recently forfeited to the Peterson Lake, has been handed over to the Mercer Silver Mines, Ltd., which has commenced operations. The Belle Ellen, in South Lorrain, is resuming development work.

ZINC PRODUCTION. — For some time the Canadian Government has been endeavouring to encourage the establishment of zinc refineries in order to secure a supply of the zinc needed for the manufacture of munitions. The manufacturers who have undertaken contracts have had to import zinc from the United States at very high prices, and the continuance of a supply from this source is uncertain. The principal object in the way of starting Canadian refineries was the prospect of loss of the large investment required in case of the speedy termination of the war. The zinc producers required the guarantee of a profitable market for some time as a condition to engaging in the industry. To meet their views the Government as a provisional measure has by Order-in-Council granted a bonus on a sliding scale not exceeding 2c. per lb. on zinc extracted from Canadian ores under certain conditions. It will not be paid on ore produced during the continuance of the war or after July 31, 1917, neither will it come into force unless the standard price of zinc in London falls below £33 per ton of 2000 lb., and the total bounty to be paid is not to exceed $400,000. No bounty will be allowed on zinc contracted for by the Shell Committee at 8c. per lb. or over. The effect of the bounty measure under these limitations is simply to secure the producers against the loss of the capital invested, which would be caused by an early cessation of hostilities followed by a fall in prices. Arrangements have been made for the establishment of two plants, one at Trail, B.C., by interests associated with the Consolidated Mining & Smelting Co. who own the smelter there, and the other at Welland, Ontario, by the Canadian Zinc Co., a newly incorporated organization with a capital of $500,000 backed by the Weedon Mining Co., which has large zinc deposits in Quebec province. Contracts for several thousand tons have been already given out by the Shell Committee.

CORNWALL

THE SUMMER meeting of the Royal Cornwall Polytechnic Society, held at Falmouth from August 31 to September 2 inclusive, seems likely to prove one of the most significant as it was one of the most interesting in the history of this famous society. No elaborate exhibition was attempted this year, though the Secretary, Mr. E. W. Newton, got together a small but interesting collection of British-made goods that are being and may be substituted for those previously bought in Germany. Attention, however, centred mainly on the technical papers read and their discussion. Of the three Cornish staples, "fish, tin, and copper," tin came in for the main consideration, China clay usurping the place of copper in the programme, as it has largely done in local interest and importance. The programme was not entirely technical, as Mr. Henry Jenner discussed the folk-lore of Piskies, and Mr. Frank B. Browne gave an illustrated lecture on 'The Fly Problem,' but the chief feature of the meeting was the presentation by Mr. W. H. Trewartha-James of the paper by the late J. J. Beringer on 'The Physical

Condition of Cassiterite in Cornish Mill Products,' and the resulting discussion. This was the first reading of the paper to the 'home folks,' though it was presented and elaborately discussed before the Institution of Mining and Metallurgy some weeks ago. Additional work, conducted by Mr. H. R. Beringer and Professor Davidson, of the Camborne School of Mines, allowed a fuller discussion of the condition of cassiterite in the uncrushed ore, and microscopic and additional lantern demonstrations of much value. Mr. Trewartha-James summarized the paper briefly and clearly, and directed the discussion toward the practical problem of what constituted the next step in the difficult matter of reducing losses in tin-dressing. The discussion was participated in by Messrs. R. Arthur Thomas, Josiah Paull, Nicholas Trestrail, Morley Martin, Horton Bolitho, M. T. Taylor, Stephen Vivian, H. Foster Bain, J. M. Coon, and H. Stadler. The general concensus of opinion was that tin losses were heavy, that present practice had about reached its limit of economical efficiency, that additional studies were necessary as to the fineness of the mineral in the rock, the possible improvement of methods of crushing, and of the availability of new processes supplementary to wet concentration. There was a refreshing frankness in admitting losses and an evident open-mindedness toward improvement. At the close of the discussion Mr. W. L. Fox presented a resolution which was duly adopted, proposing that the Polytechnic invite the co-operation of the Institution of Mining and Metallurgy in the further scientific study of these problems. Mr. C. McDermid, secretary of the Institution, in a few words expressed his belief in the willingness of the Council of the Institution to accept the charge, and so what may well become a new policy of large economic importance, the co-operative stimulation of technical research, was initiated. On the following day Mr. J. H. Collins presented a scholarly and informing paper on 'The Occurrence of Tin and Tungsten in the West of England' and Mr. Bain one on 'Prospects for Tin in the United States.' Mr. Collins announced his belief that until many more mines were thoroughly explored to a depth of at least 600 fathoms, it was too soon to discuss any probable lower limit for tin ore in Cornwall comparable to that already determined for copper. He also stated that it would be much better to spend money on exploring and deepening many of the shallow mines rather than draining and re-opening those that were already deep; an opinion, coming from one so intimately acquainted with the country, that is of great importance.

The China clay industry came in for discussion in connection with Mr. J. M. Coon's paper on 'Development of Mechanical Methods in China Clay Mines.' The paper was a historical discussion of the progress from exclusively hand work and air drying to the modern methods of hydraulicking the clay, hauling the sand out of the pits with tramcars, sending the washed clay through pipe-lines to the drying stations, and handling the material there into railway vans. Mr. Coon pointed out that many appliances had been tried which had failed, and others were still on trial. Centrifugal pumps were not yet used in the deeper pits, and the final verdict regarding filter-presses had not been given. In the discussion Mr. Stephen Vivian pointed out that mechanically it was wrong to put 98 tons of water into a pit in order to pump out 2 tons of clay, all the more since the sand and waste must still be brought up by mechanical means, and he suggested as one of the problems for the future the development of a system of mining the whole mass and extracting the clay at the surface. This and various problems relating to drying were discussed at some length, and it was proposed that the Polytechnic take the lead in studying possible improvements in clay-mining as well as in tin-dressing. The China clay industry has become very important in Cornwall in recent years and despite temporary difficulties incident to restriction on shipments during the war, is one of the big industries of the county. If the Polytechnic takes the lead in proposing improvements in mining methods it will be quite in line with the history of the institution, which subsidized the building of the first man-engine and aided the development of the dipping-needle and other useful instruments.

TIN OUTPUT.—The tin mines continue to suffer from the low price of tin, the increased cost of supplies, and the absence of so many of the miners who have enlisted. The Dolcoath has the additional worry that developments at depth are still disappointing. The production of concentrate is now only about 80 tons per month, a fall of 40% as compared with two years ago. The Carn Brea & Tincroft has been able to maintain its output and income on the reduced scale after the restriction of production two years ago following on the exhaustion of reserves in several sections. The yield per ton during the first half of the current year was 23·4 lb.

PERSONAL.

J. A. AGNEW has recovered after his operation and is back at his office.

S. AIMETTI has resigned as general manager of the Transvaal Gold Mining Estates and has gone to Italy to fight for his country.

J. FORDYCE BALFOUR is a member of the new Nigerian Council, representing the mining industry.

HOWLAND BANCROFT has gone from the United States to Bolivia with the object of examining tin properties.

P. A. BOISSIER has left for the Federated Malay States.

ALBERT BURCH has resigned as consulting engineer to the Goldfield Consolidated, Nevada.

GELASIO CAETANI has a commission in the Aviation Corps of the Italian Army.

J. M. CALDERWOOD is here from Johannesburg.

COLIN CAMPBELL is expected from Rhodesia.

W. McC. CAMERON, for some years consulting engineer in South Africa to A. Goerz & Co., resigns this position in March next.

A. R. CANNING has left for Nigeria.

S. W. CARPENTER has left for Nigeria.

W. S. CARR is here from Johannesburg.

J. D. CONNOR has been appointed by the South Australian Government to inquire into the treatment of low-grade copper ores in the State by leaching methods, and will visit the chief copper centres in America with a view of studying the latest practice there.

J. H. CURLE has been detached from field service to assist in the work of the Parliamentary Savings Committee.

H. S. DENNY is manufacturing high explosives in North Wales.

D. B. DONOVAN has taken charge of the survey department of the Consolidated Gold Fields group of mines in West Africa.

H. T. DURANT has a commission with the 13th Hampshire Regiment.

C. P. FLOCKART has left Australia to take an appointment on the staff of the Champion Reef, India.

W. L. HONNOLD is on the advisory committee of the Commission for Relief in Belgium, and will devote the whole of his time to the work.

C. S. HERZIG is in Utah.

W. INGHAM, chief engineer to the Rand Water Board, has been elected president of the South African Institution of Engineers.

HENRY D. A. MAIDMENT has returned from the Sotiel Coronada mine, in the south of Spain.

VAN H. MANNING and GEORGE S. RICE are in California.

KENNETH A. MICKLE is here from Burma.

FRANCIS OATS left for South Africa on August 14.

R. B. OLIVER and W. G. PATTISON left for the Belgian Congo on September 6.

OSBORNE & CHAPPEL have been appointed managers of the Lahat mines, Perak.

B. D. PLUMMER has returned from Egypt and has received a commission with the Northumberland Fusiliers.

FRANK H. PROBERT has opened an office at Hobart Building, San Francisco.

A. L. QUENEAU, who is with the Royal Engineers, has received the Distinguished Conduct Medal and also the French Croix de Guerre. His eyes were seriously injured by gas at the battle of Ypres, but he has fortunately recovered.

F. S. SANDERSON, lately with the Mount Morgan Company, is now with the Sulphide Corporation, at Cockle Creek.

CHARLES A. SMITH has accepted a position on the metallurgical staff of the Union Minière du Haut Katanga.

H. L. TEMPLER, of the Ferreira Deep, has arrived in England, and has received a commission in the Royal Engineers.

W. H. TREWARTHA-JAMES, STEPHEN VIVIAN, C. McDERMID, H. STADLER, and H. FOSTER BAIN went down from London to the meeting of the Royal Cornwall Polytechnic Society.

EWAN TULLOCH, 2nd Lieutenant in the Royal Engineers, has been awarded the Military Cross.

CHARLES E. VAN BARNEVELD has been appointed Acting Professor of Mining in the University of California.

J. T. WARNE is home from West Africa.

GEORGE WEIR has been appointed general manager for the North Broken Hill company at Melbourne as well as manager at the mine.

HENRY M. WHITE is with the Cordoba Copper Company at Cerro Muriano, Spain.

A. STANLEY WILLIAMS has left for Northern Nigeria.

WALTER HARVEY WEED is examining a copper property in Newfoundland.

OLIVER WETHERED is recovering from his serious illness, but is not yet allowed to leave his home.

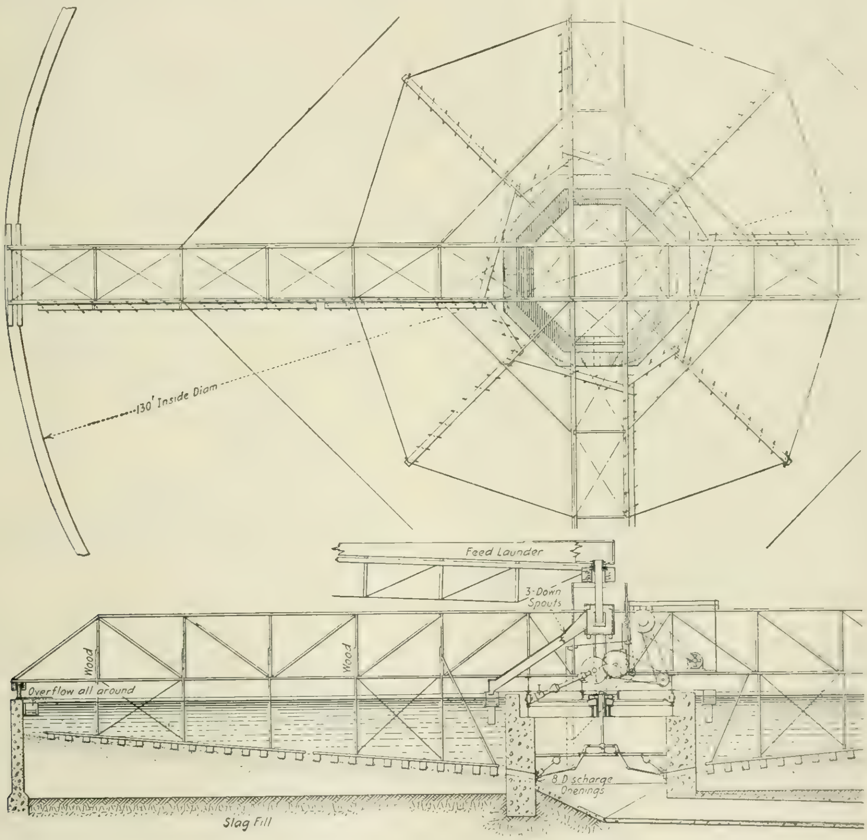
ERNEST R. WOAKES is in Spain.

POPE YEATMAN has returned to the United States from Chile.

PRECIS OF TECHNOLOGY

[Copies of the original papers and articles mentioned under this heading can be obtained on application to the Technical Bookshop, Salisbury House, London, E.C., the book department of The Mining Magazine.]

Dorr Thickener for Copper Tailing.—In the *Engineering and Mining Journal* for July 24, David Cole gives particulars of an unusually large Dorr thickener employed for recovering the water from the concentrators and discharging the settled slime to the delivery flume. This thickener was originally built as a settling tank for sand, which was to be used for filling exhausted stopes. On the abandonment of the use of sand for stope-filling, the settling tank was requisitioned for removing the slime from the tailing water. The clarified water is returned to the concentrating plant, and the thickened slime to a flume along which it is carried for a considerable distance. The tank is 130 ft. inside diameter and 10 ft. deep, with a hollow octagonal pier in the middle 21 ft. mean diameter. The structure is of reinforced concrete, and the foundations consist of an old slag pile. The bottom of the tank was not impervious to water, but first of all the sand, and subsequently the slime, have cemented all possible outlets. The floor of the tank was originally level, and under the present arrangement the accumulation of hardened slime forms a bank, 2 ft. deep at the centre and about 7 ft. deep at the outer wall. The discharge of thickened slime takes place intermittently through eight openings controlled by 3-in. valves opened at intervals by cams. The system of rakes is suspended from a cruciform bridge, the outer ends of which run on a rail on the top of the circular wall. The speed of the rakes is about 2 revolutions per hour. The power required is 5 h.p. The average feed is equal to 700 tons of dry slime per 24 hours. The average percentage of solids in the feed is 5·93, and in the discharge 30·65. The amount of water recovered is approximately 1700 gallons per minute, and the percentage of recovery 85·75. It would be easy to recover a greater proportion of water by increasing the percentage of solids in the discharge to 50%, but as the thickened slime has to be conveyed by flume a distance of 2 miles, it is not advantageous to do so. If large thickeners were made on this principle expressly for this class of work, the central pier would be narrower, and the bottom would be built in conical shape. As regards the effect of cold, Mr. Cole considers that it will be cheaper to heat the water than to build houses over them that have to be warmed.

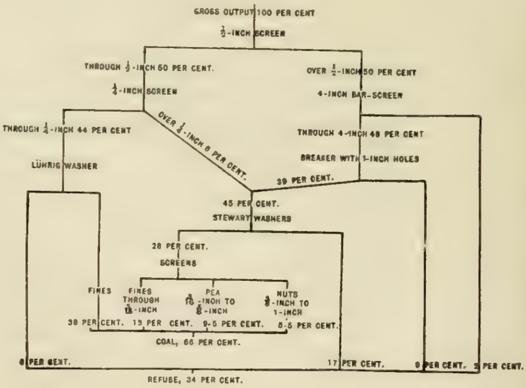


Dorr Thickener for Dewatering Slime Tailing at the Arizona Copper Co.'s Concentrating Plant.

Potash from Sea-weed.—In our issue of June 1912, we gave a précis of an article describing the ancient industry of extracting potash from sea-weed, the object of the article being to revive this source of potash owing to the imposition of a protective export duty on the potash salts mined at Stassfurt, Germany.

The situation created by this duty has been intensified by the war, and in both Great Britain and the United States the shortage of the potash supply is acute. Off the Scottish and Irish coasts the sea-weed drift is plentiful. With the object of interesting local labour, the Scottish Board of Agriculture has issued a pamphlet giving instructions with regard to the collection of the sea-weed and the preparation of kelp therefrom; the kelp is in demand not only for the potash but for the iodine contained. In the Orkney and Shetland islands and in the Hebrides the industry has gradually revived during the last three or four years, and recently the demand for kelp on the part of British chemical manufacturers has greatly increased. After the sea-weed has been collected, it must be dried and then burnt. The 'kelp' is the residue, and on an average one ton is obtained from 5 tons of sea-weed. Different varieties of sea-weed contain varying proportions of soda and potash. The soda weed is known as 'black wrack' or 'cut weed,' that is cut from the rocks, and the potash weed as 'red wrack' or 'drift weed.' Black wrack has not been collected for over a hundred years, for the manufacture of soda from rock salt and brine caused the demand to vanish. The red wrack or drift weed is known as 'tangles,' Latin name *laminaria stenophylla*, which is cast-up on the beaches in winter, and a similar weed, *Laminaria digitata*, which reaches the shore in spring and summer. It is desirable that collectors should be instructed with regard to the differences between these varieties of weed. The weed should be gathered, dried, and burnt as soon as possible, for if left on the beach for a day or two some proportion of the salts will disappear. Only weed with unbroken stalks should be collected. Moreover, the weed should be kept away from fresh water, as much of the potash salts will be dissolved out. The process of drying consists of spreading the weed on the sand; in winter it is desirable to make little sand banks 2 ft. long and 9 in. wide and place the main stalks on the top of the banks, allowing the ends to hang down on each side, thus facilitating the drying by draining. When the weed is dry it is collected into heaps and burnt, to kelp or ash. The burning should be done carefully and slowly. Slow burning obviates loss of potash and iodine. Sometimes the kelp is burnt to a hard slag and sometimes to ash. The kelp must be bagged as soon as possible and kept quite dry, otherwise the soluble salts will be partly lost. The price received for the kelp per ton is about £6, perhaps more now. Analyses of the kelp give about 30% of potassium sulphate and chloride, and about 1% of sodium iodide. The insoluble matter consists largely of calcium carbonate, and calcium and magnesium phosphates. In the south of England and in France, sea-weed is used in its raw state as a fertilizer

Coal Mining in Mexico.—In a paper read before the North of England Institute of Mining and Mechanical Engineers in April, Mr. E. O. Forster Brown gives an excellent general account of the coalfields and coal mines of Coahuila, Mexico. As these mines are the only ones in the Republic and the source of the coke needed for local smelting, except that imported, the paper is of wide interest. In 1912 there were nine colliery companies operating, of which five were Mexican, three American, and one British. They were not seriously affected by the revolution prior to 1913, since when the destruction of plant has been most serious. According to Mr. Brown's figures, the normal yearly production is about 1,800,000 tons, of which approximately 700,000 tons is consumed in making 250,000 tons of coke, the remainder being sold for steaming and domestic purposes. In addition 800,000 tons of coal and about 300,000 tons of coke are imported. These figures are for the years 1909 to 1911 inclusive. The coal occurs in the Upper Cretaceous, and the collieries probably all work on the same bed, though owing to faulting and cover the matter is not beyond doubt. Other beds occur, but are as yet of doubtful economic value. The main output is from the Sabinas basin, which is 30 by 12½ miles in extent. The dip is about 6°, and the average thickness 6 to 8 ft. The maximum depth in the basin is 800 ft., but the working shafts mentioned are much less, 164 ft. to 223 ft. Analyses of mine-run dry coal after picking show 19 to 27% ash, 50 to 61% fixed carbon, and 1 to 2% sulphur. Workings are by room and pillar according to a plan common in American mines. The coal dust is only moderately sensitive, but the presence of fire damp has led to a number of explosions. The mines are dry. The coal beds contain thin bands of shale and also of 'bone' coal. Since the coke yield is of great importance, careful washing and screening is necessary in order to market the output. An unusual flow-sheet has been devised, in which all the coal goes first over a ½-in. screen, the

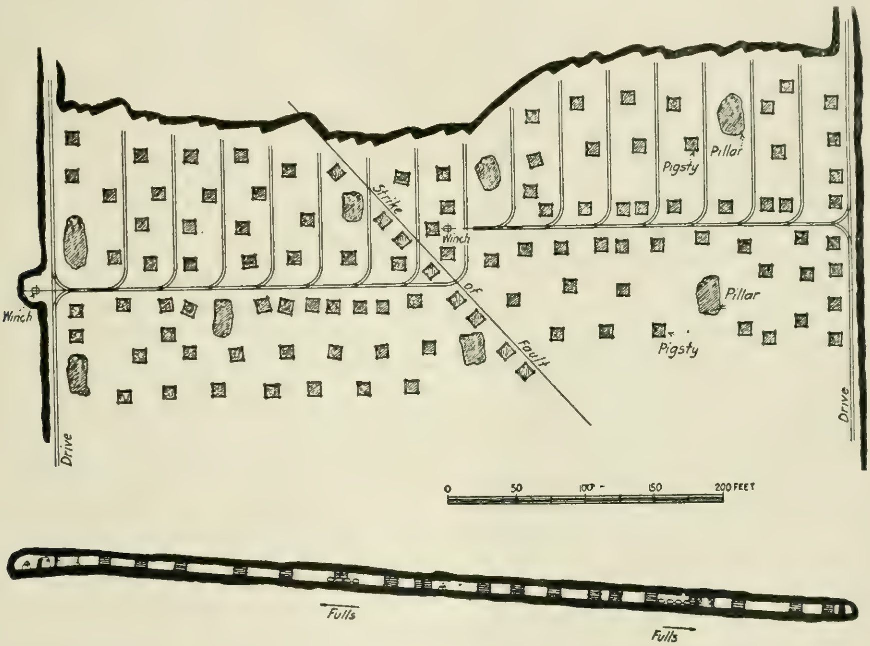


fine going in part to Luhrig washers and in part to Stewart washers, where it is joined by a second lot of fine coal coming from 4-in. screens that follow the original ½-in. The coarse coal passes through a revolving trommel with 1-in. holes and fitted with interior shelves, the effect being to break the product and screen out dry 11% refuse mechanically rejected. The total refuse amounts to 34%, and its disposal constitutes an unsolved problem, all the more because it contains sufficient coal as delivered from the Stewart washer to afford 6906 B.T.U. and from the Luhrig 8346. The coke yield at El Menor and Palau is 64% and a proximate analysis of the coke shows:

	Per cent.
Moisture	1·35
Volatile	1·70
Fixed carbon	82·25
Ash	14·70
Total	100·00
Sulphur	0·91

Competition of petroleum has cut into the coal business, but as a whole the industry has been on a sound basis. The cost of working is given at 6s. to 9s. per ton gross, including all expenses except directors' fees and depreciation. The selling price at the pits in normal times ranged from 9s. to 13s. for coal and 19s. to 26s. for coke.

Mining Conditions on the Witwatersrand.—Mr. W. L. Honnold has prepared for the San Francisco meeting of the American Institute of Mining Engineers an interesting and valuable account of the underground factors that govern mining on the Rand, with special reference to the great Far East areas now being opened. His remarks are illustrated with details and drawings based upon workings in the Brakpan and Springs mines. Mr. Honnold states his opinion that "the average quantity of gold per unit of reef-area lessens in depth and the ore deposits show more instances of lower than higher grade." "Decreasing average grade however," he says, "is not the only factor involved, nor is it of the relative importance usually assumed." The Village Deep, at 7000 ft. horizontal from the outcrop and 4600 vertical depth, shows "practically continuous ore of good stoping width and better than the average grade of the mine for over 5000 ft. along the strike." The Brakpan, at 4100 ft. deep and 4 miles from the outcrop, shows orebodies "clearly segregated, irregular as to occurrence and shape, of good thickness and large enough to be stoped separately, some measuring 700 ft. along the strike and more than 4000 ft. on dip. While they show a general tenor below that of neighbouring mines nearer the outcrop, yet their average is approximately that of the Rand today. In the Springs mine, at 3750 ft. deep and 7 miles from the outcrop, with 60 acres of ground open, the average orebody shows 10·3 dwt. over a stoping width of 52 in." From these facts, Mr. Honnold considers that "the future of the Rand is perhaps more dependent on the quantity than the quality of the ore yet to be developed." As to general conditions he points out that because of transport charges the cost of supplies is high, while local coal supplies and central stations make power costs low. The character of the rock and of the labour imposes a charge of more than £600,000 per year because of phthisis, and the presence of both white and black men introduces many peculiar local problems. The Brakpan spent £34,500 in preliminary drilling, and then £1,180,000 over 8½ years before beginning milling. The mine is opened by two shafts 42 by 9 ft. in cross-section, the large size being necessary on account of ventilation problems. These shafts are 3707 and 3098 ft. deep and connected by an 18 ft. main haulage-way 4500 ft. long. From this are turned off main drifts or entries much as in a coal mine. These are then connected with winzes from which stope drifts are opened to the face. At the head of each winze is a winch for handling trucks of ore from the stope and half-way down to the next level is a second for handling trucks from the lower part of the stope. The areas or 'patches' of ore are of such size and position with reference to the main levels, having their longer diameter down the dip, that more than one rise is seldom used. As a result ore reserves are calculated on the basis of sampling first two faces and later a third. The ground is supported by pillars and pigstys. Ore in the pillars and timber in the stys can be largely recovered, the roof being allowed to cave, and stope-filling seems not to be needed owing to the way the roof breaks and the fact that the orebodies are sufficiently distinct to preclude a 'squeeze' starting when they are mined. Both large 3¼ and small 2¾ machines are used in stoping. The former show an efficiency of 11 tons per machine shift and the small ones 7 tons. The low efficiency is due to labour conditions. The cost of stoping in 1914 was 4s. and 5s. per ton broken. On an average tons-milled basis this becomes 4s. 3d. Transportation is a most important factor in such mines. The one-ton trucks are filled and delivered to the winzes on piece work at a cost of 4d. to 5d. per ton. This requires 43% of the native labour. The cost of shovelling and tramming in 1914 was 2s. 10d. per ton, all charges included. Contin-



DIAGRAMMATIC SKETCH SHOWING STOPING METHODS AT THE BRAKPAN.

uous wire rope, travelling two miles per hour, is used on the levels. In 1914, 705,775 tons was delivered to shaft bins at a cost of 5d. per ton, of which charge 75% represented labour and 5% power. The charge also covered handling supplies and tools. The grade of the ore milled is controlled by varying the amount taken from stopes, from development, and from miscellaneous, such as pillars, hanging-wall leaders, and similar sources. The Springs mine, after spending £850,000 over six years, is now ready to spend £300,000 to £400,000 over ten years to provide milling facilities. The general plan is similar to that at the Brakpan, though there are interesting differences in detail.

Accidents due to Explosives.—In our July issue we gave an abstract of a paper by W. Cullen read before the Chemical, Metallurgical, & Mining Society of South Africa at the March meeting, entitled 'Safety Measures in the Use of Explosives.' In the May issue of the *Journal* of the Society, J. D. Marquard contributes to the discussion, and enters into considerable detail as to the causes of these accidents, and he tabulates no less than thirty-five causes for misfires. We extract some of his remarks.

Improper distribution of detonating force accounts for the bottom cartridges not being exploded. The force travels through the primer and cartridges instantaneously on detonation, and is not transmitted by a series of explosions from one to another, so all the cartridges must be in contact. If a weak detonator is used, the force of detonation will not always travel along to the last cartridge. If the detonator becomes damp, it rapidly loses its power; experiments exposing detonators in the vicinity of damp material have shown that the detonating force was entirely destroyed in five days. If the sawdust used in packing is left on the detonator it is set alight by the fuse, and as there is not enough oxygen for the complete burning of the sawdust, it smothers out before the heat gets to the fulminate. In charging wet holes, miners sometimes dip the ends of the fuses into grease before fixing them to the detonators, instead of first crimping the detonators on to the clean fuses and then greasing the junctions; under such conditions the detonators often fail to explode. In some cases the hole is charged with the fulminate end of the detonator pointing away from the cartridges. For instance, in shaft-sinking it is common to have the primer cartridge at the bottom of the hole, the open end covered by five cartridges. Also some miners put the primers in ordinary stoping holes upside down with the detonators foremost and the fuse coming along the side of the primer. In both these cases some of the cartridges may be unexploded. For the same reason it is desirable that the axis of the detonator shall be in exact line with the axis of the charge. In charging the hole it is possible that through carelessness the detonator and fuse may become separated from the primer, and subsequently in tamping the hole some of the clay may pass between the detonator and the cartridge; this will cause a partial or total misfire. If the detonator is crimped on to the fuse too hard, the fuse may side-spit and not ignite the detonator. The continuity of the fuse may be destroyed by letting the fuse get into contact with oil, or by exposing the coils of fuse to flying rock. Careful and complete tamping is necessary, for if any opening or weakness is present the force of the detonation will be reduced. As regards exudation of nitro-glycerine, damp is well known to cause this, and it will also occur if the cartridges are left in a hot part of the mine for any length of time. Moreover, if the boxes of cartridges are stored on end, the undue pressure on the bottom cartridges will squeeze-out some of the nitro-glycerine, It is possible for the explosive charge to catch fire and burn gently without explosion; then part of it will be smothered and remain unburnt. This may happen if the primer is at the bottom of the hole, and the fuse passed along the side of the cartridges. Mr. Marquard prefers a long wooden rod shod with a copper cap as a charging-stick. A stick made of copper or brass, or of wood sheathed with metal is too heavy, and a powerful miner would be apt to give too hard a blow. It is desirable, however, to have some protection for the ends of the wooden rod, for the ends get frayed, bits of grit become attached, and the grits are a source of danger. Also the metal cap prevents the miner from paring the end of the stick and so unintentionally making a dangerous point.

Sale-Contract for Bolivian Tin Concentrate.—The *Mining and Scientific Press* for July 31 contains details of a specimen contract between a Bolivian mining company and a Liverpool firm of tin smelters, relating to the delivery of about 80 tons of tin concentrate monthly for a period of six months.

The weighing and sampling in the ore-yard at Liverpool is done at the sellers' expense. An assayer in Liverpool acts for the sellers. The assays are to be exchanged between the assayer and the buyers by letter by the same post. The assays are to be made to two places of decimals. Should the figures differ by more than 0·5%, either party can demand that the third sample shall be sent to an assayer in Truro or London. If the referees' assay is between the two, their figures shall be adopted; if not, the buyers' or sellers' figures nearest to the referees' figures shall be adopted. Moisture loss is to be ascertained separately, from sealed-bottle samples, and the figures settled in the same way. The tin price regulating the contract is the mean of the cash and three-months' official prices of standard tin as quoted on the London Metal Exchange on the 14 days following the day on which the steamer is reported in the Liverpool customs bill of entry. These averages are to be converted to the nearest even five shillings. From the percentage of metal content is deducted units as per the following table:

Percentage of Tin, or over	Units deducted	Percentage of Tin, or over	Units deducted
74	2·00	64	3·40
73	2·125	63	3·55
72	2·25	62	3·70
71	2·375	61	3·85
70	2·50	60	4·00
69	2·65	59	4·15
68	2·80	58	4·30
67	2·95	57	4·45
66	3·10	56	4·60
65	3·25	55	4·75

The reduced percentage is multiplied by the agreed average price of the metal and divided by 100. From the result thus obtained is deducted a returning charge of £6 for concentrate assaying 60% or over, and for concentrate assaying less, down to the minimum of 55%, a further deduction of 2s. 6d. is made per unit below 60%. Should the total of antimony, copper, and bismuth contents exceed 0·25%, 2s. 6d. per ton is deducted for each 0·1% above 0·25%, and the total content shall not be above 0·75%. As regards payment, 90% of the approximate value shall be paid in London against delivery order on the day the concentrate is sampled in Liverpool, and the balance on the settlement of assays and receipt of invoice.

A characteristic assay of the concentrate forming the basis of this contract is as follows:

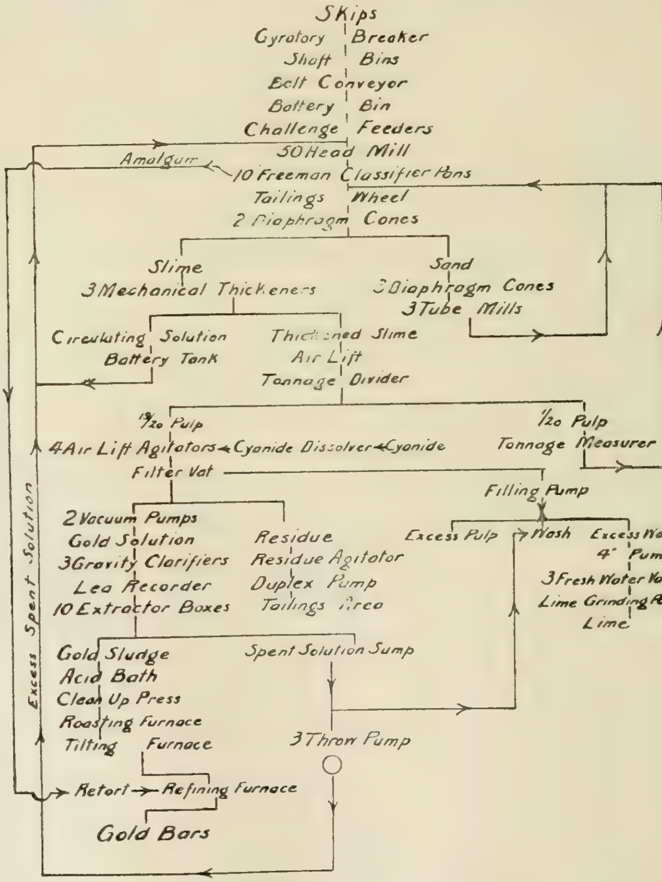
	Per cent.
Tin Oxide ...	78·350
Iron	5.584
Manganese	0·022
Nickel	0·047
Copper	0·105
Bismuth	0·020
Lead	0·034
Arsenic	1·450
Titanium Oxide	0·200
Tungstic Acid	0·090
Silica	8·430
Sulphur	1·680
Zinc and Antimony	Traces
Silver	Trace
Combined Water and Oxygen	3·888
Total	100·000

The assayer, in his report, says that the concentrate is of medium quality, and that it has not been roasted or treated in magnetic separators. The 78·35% of tin oxide corresponds to 61·75% metallic tin. To give an example of the calculation of price, we may take £160 as the agreed average for the price of metallic tin. As the percentage of metal is over 61, the deduction of units is 3·85, leaving 57·9. Multiplying this by 160 and dividing by 100, we get £92. 6s. 4d. As the percentage of metal is over 60, the returning charge is £6, leaving £86. 12s. 9d. as the price per ton of concentrate. The copper, bismuth, and antimony content is below the minimum stipulated, so there is no deduction on this score. The cost of sampling and handling in the Liverpool ore-yard has to be paid by the sellers, and also the fee of the assayer representing them, before the net receipts on delivery in England can be ascertained.

Smelting with Oil Fuel.—The *Canadian Mining Journal* for August 1 contains a paper by Allan Bruce Marquand describing an experimental furnace built to test a process invented by J. and W. Heslewood. This process has for its object the prevention of the formation of sulphurous acid in smelting operations and the production of elemental sulphur instead. This object is the same as that which formed the basis of Hall's sulphur process described in our issues of August 1913 and February 1914, but the furnace is of a different type and crude petroleum is used as fuel. The ore is desulphurized and smelted in a double-compartment shaft-furnace so arranged that after desulphurization has been carried to the desired point in the upper compartment the ore is dropped to the lower compartment and there smelted. Crude oil fuel is used for the double purpose of supplying heat and an important chemical re-agent, hydrogen. Steam is admitted to both compartments to control the temperature in the desulphurizing zone and to furnish hydrogen and oxygen in both zones. The resulting furnace atmosphere is decidedly reducing, its nature being determined by the relative amounts of oil, steam, and air admitted. The product passing from the desulphurizing into the smelting zone ranges from [illegible] to [illegible]% sulphur. The smelted products are slag and matte. The passage of gases through the charge is caused by a vacuum draught generated by a water-jet pump. The gases are discharged through a specially designed vacuum chamber and a tank. Here all solid particles and substances which are condensed at this temperature are precipitated as the gases rise through the water. This solid material will be largely sulphur and unburned carbon, while the gaseous products consist chiefly of carbon dioxide, some carbon monoxide, a perceptible percentage of sulphuretted hydrogen, a trace of sulphur dioxide, and a small amount of sulphur-carbon compounds, such as carbon bisulphide. Mr. Marquand gives an account of a series of tests showing how sulphuretted hydrogen is formed by the reaction of hydrocarbons on pyrite, and how, subsequently, the sulphuretted hydrogen is made to react on sulphurous acid for the production of elemental sulphur.

Electrolytic Zinc.—In our issue of September 1912 we gave a short notice of an electrolytic zinc process invented by A. Gordon French, of Nelson, British Columbia. In those days British Columbian zinc ores were virtually unsaleable, and the Belgian, German, and American smelting furnaces could supply the world's demand for zinc. Metallic zinc is scarce in the British Empire nowadays, and the cost of a smelting plant and the length of time required to build it and work out the details are serious obstacles to the inauguration of a smelting industry. Attention is being turned in England, France, and Canada to electrolytic methods. We therefore quote an account of the 'French' process that was published in the *Bulletin* of the Canadian Mining Institute for August. The 'French' process consists in the use of a solution of bisulphate of soda, which is a cheap waste product, and a small quantity of manganese, an ingredient which occurs with most zinc ores. Bisulphate of soda rapidly dissolves the zinc from the roasted ore. Along with the manganese in solution, it completely prevents the anodes from being affected. This solution has little resistance to the passage of the electric current in the electrolytic vats, and the consumption of current is thus lowered. It has also the peculiarity of throwing out of solution practically all the impurities which usually contaminate the zinc. Early in 1912 the Consolidated Mining & Smelting Company of Canada acquired the sole rights for the use of this process in Canada, but after they had produced a few tons of zinc the contract between French's company and the Consolidated was cancelled on account of disagreement and alleged violation of contract. A demonstrating plant was then erected at Silverton, on Slocan lake, by the Standard Silver-Lead Mining Co. to prove that the process would work on a large scale. It comprised two completely equipped dissolving vats, each capable of dealing with 2000 lb. of liquor at a time and about 1000 lb. of ore. The zinc depleted liquor containing bisulphate of soda from the electrolytic vat is pumped into the upper of these two vats. There is then added 700 to 1000 lb. of roasted ore from which the zinc had been partly extracted in a previous operation. In about an hour [illegible] of the zinc is finished and when the liquor has settled for a short time it is allowed to run down into the second dissolver placed at a lower level. The sludge remaining in the bottom of the dissolver is then pumped through a filter press to remove the water and the residue contains all the silver and lead. As the sulphur to the extent of more than [illegible]% had been driven off in the roasting operation and zinc to the amount of about [illegible]% had been extracted, the residue of the ore only weighed about [illegible]% of the original ore used. As it contained all the silver and lead originally in the roasted ore the percentage of these metals was more than doubled. For instance the ore treated assayed [illegible]% zinc, [illegible]% lead, and [illegible] oz. silver per ton. The zinc-depleted residue contained [illegible] oz. silver per ton and [illegible]% lead, and [illegible]% of the zinc had been taken out, that is [illegible]% of the zinc contained in the original ore used was left in the residue. The resdue is now ready for smelting or other treatment for the recovery of its lead and silver in the usual way. To the liquor which has been run down into the second dissolver, a quantity of roasted ore is again added to neutralize the bisulphate of soda. As soon as this has taken place, the liquid settles rapidly to a clear solution, which is pumped through a clarifying filter-press, and is then ready to have its zinc deposited in the electrolytic vats. At the Standard Company's plant only one electrolytic vat was used, as the dynamo power at disposal was limited. Nine anodes were used and eight cathodes of the largest size, each with an area of 8 sq. ft. Although 4000 kilowatt-hours were allowed in costing for the deposition of one ton of zinc, only 3000 kilowatt-hours were actually required, the lowest reading over a period of 48 hours having been 2680 kilowatt-hours. As the zinc is deposited from solution in the electrolytic vat, the bisulphate of soda with which it was combined is regenerated and is used again in the next dissolving. The working costs vary with the ore, but they are now well defined. The plant is expensive, but much less than that required for a zinc smelter of similar capacity. Ores of almost any grade above 10% zinc can be treated equally well, but naturally the cost of treatment for an ore with a larger zinc content is less.

Metallurgy at Sons of Gwalia.—The *Monthly Journal* of the Chamber of Mines of Western Australia for June contains an article written by A. Wauchope, the general manager, describing the present system of metallurgical treatment at the Sons of Gwalia gold mine, at Mount Leonora, West Australia. This mine has been in operation successfully since 1898. Four years ago the results of development on the main lode became disappointing, but by a campaign of lateral exploration suggested by Malcolm Maclaren a parallel lode was discovered. The latest report recorded that the ore reserve was sufficient for four years and that developments had continued to be satisfactory. Until two years ago the metallurgical treatment consisted of reduction in stamp-mills, amalgamation in pans, removal of sulphides by Wilfleys, roasting concentrate with subsequent amalgamation and cyanidation, leaching sandy tailing, and agitating slime tailing. Experiments, however, showed that the process could be greatly simplified by omitting the concentrators and roasting furnaces, and reducing the tailing after amalgamation to slime. Another alteration made was the substitution of gas engines for steam plant, and the manufacture of gas from wood. According to the last yearly report, 160,963 tons was treated, for a yield of gold worth £250,501, or 31s. 1d. per ton. The ore first goes to 50 stamps, weight 1150 lb., with screens having 6 to 8 holes per linear inch. The discharge averages 40% of plus 60 and 50% of minus 150. Throughout the plant, crushing is done in weak cyanide solution. No amalgamation is done in the stamps or on plates, but the pulp is delivered to ten 5-ft. Forwood-Down grinding and amalgamating pans. These pans are fitted with the Freeman selective pipe discharge (described in our issue of December 1910). Mercury to the extent of 0·23 oz. per ton of ore is consumed in these pans, and about 20% of the total gold recovered at the mine is obtained in the amalgam. The tailing from the pans is elevated to classifiers, going first to two primary diaphragm cones 11 ft. high and 8 ft. diameter at the top. The slime overflow passes through a second sand-trap to thickeners, and the sandy underflow passes to three secondary diaphragm cones 8 ft. by 5 ft. The underflow of the secondary cones goes to 3 tube-mills placed in circuit. The tube-mills measure 18 ft. by 4½ ft., revolve at 27 r.p.m., have a capacity of 60 tons per day each,



FLOW-SHEET AT THE SONS OF GWALIA.

and produce a pulp containing 10% of plus 150 material. The linings are of hard corrugated iron, flint pebbles are used, the total load of pebbles for each mill is 7 tons, and the consumption of pebbles 1½ lb. per ton of ore. The overflow from the primary cones passes into three involute-arm thickening vats, each 10½ ft. deep and having a settling area of 527 sq. ft. To prevent undue disturbance in the vat the product is delivered at a point about 12 in. below the surface of the pulp in the centre of the vat. The involute collecting arms travel at the rate of one revolution in three minutes, and continuously sweep the settled slime on the bottom of the vat to a centrally situated discharge. The settled product contains 45% water. The underflow from the thickeners is elevated by an air-lift to a self-rotating distributor, by which it is delivered to the agitators. There are four agitating vats connected in series, through which the product is continuously passing. The contents pass through an inclined 6 in. pipe from the bottom of the first vat to the top of the second vat and so on. The vats are 28 ft. in diameter, and have a total capacity of 15,890 cu. ft. A small continuous stream of dissolved cyanide drips into the first of the series of agitators. Agitation is effected by mechanically-driven arms, operating at 6 r.p.m., supplemented by low-pressure compressed air introduced through a small pipe down the centre of the hollow agitator spindle to the bottom of the vat. The product from the last of the agitators passes by gravity to a vacuum filter, Cassell type. The filter vat is a rectangular chamber 34 ft. long by 10 ft. wide, and is provided at the bottom with three hopper discharges fitted with Shaw-type gates, delivering into a sunken concrete agitator provided with two sets of agitating gear. The vacuum tank accommodates 44 vertical filter leaves, each 9 ft. by 5½ ft. The filtering medium is of cotton duck stretched over frames made of 1 in. pipe attached to solid head boards. Cocoanut matting, reinforced on each leaf with about 34 vertical wood slats each 5 ft. by ⅜ in. by ½ in., is rigidly fixed between the two layers of duck by numerous rows of vertical stitching. The total clear filtering area is 4464 sq. ft. and the total load of slime (dry weight) is from 40 tons to 45 tons. The cloths have a life of about 6 months, a long life solely due to the partial softening of all water taken into the plant, the object of which is to prevent any precipitation of magnesia upon the mixing of water with the plant solutions. Were this precaution not taken, the cloths would quickly become petrified with magnesia, with a consequent clogging of the pores. The cloths are not treated with acid or otherwise, but are simply discarded when inefficient. A complete cycle of filtering operations occupies about two hours. The maximum vacuum during filtering is about 25 in., and the minimum during transfer about 7 in. barometrical pressure at an elevation of 1400 ft. above sea level. The cakes are blown off the filter-leaves with compressed air, and fall through the hopper bottom into the sunken agitator, whence the product, diluted with mine salt water, is pumped to the tailing area. The excess pulp and washes are stored in their respective agitating vats, whence they are re-elevated to the filter vat by a 10 in. centrifugal pump. Vacuum is maintained by wet vacuum pumps, which also elevate the filtered liquors to the clarifying vats. A device for preventing the cakes from cracking and falling off the filter leaves between the changes of wash consists of a number of sprays which are in operation during the changing periods when they drench the cakes with a cloud of fine spray. At the same time this spray of solution also washes down the sides of the vat during the withdrawing of the pulp or washes, and so prevents salting of the following wash. This device has assisted in reducing the soluble gold losses in the discharge of pulp to a minimum. The vacuum pumps deliver the solutions from the vacuum-filter to three vats, each 29 ft. in diameter by 7 ft. deep, and fitted with a nest of filter-leaves, similar to, but smaller than those employed in the vacuum-filter. The solution gravitates through these leaves to the tonnage recorder in a perfectly clear state. Approximately 750 tons of solution is clarified daily in these clarifiers. The remainder of the installation, comprising the precipitation and smelting plant, do not call for special notice.

CURRENT LITERATURE

[Copies of the original papers and articles mentioned under this heading can be obtained on application to the Technical Bookshop, Salisbury House, London E.C., the book department of The Mining Magazine.]

Churn-Drills.—In the *Engineering and Mining Journal* for August 21, Frederick G. Moses gives suggestions for improving the methods of sampling in connection with churn-drilling.

Drilling at Mesabi.—The *Engineering and Mining Journal* for July 31 contains an article by J. F. Wolff describing the method of exploring the iron ore deposits in the Mesabi district, Minnesota, by means of a combination of diamond and churn drilling.

Corinthian North Mine.—The *Quarterly Proceedings* of the Australasian Institute of Mining Engineers, No. 18, 1915, contains a paper by V. F. Stanley Low describing the mine and plant of the Corinthian North company, at Southern Cross, West Australia. The working costs are unusually low.

Flotation in America.—The *Mining and Scientific Press* for July 31 reprints an article from the California Journal of Technology for November 1903, written by three students of the University of California, describing their researches into flotation. It is appropriate that this article should be put on record, for it contains some of the earliest investigations into the application of bubbles as foam for floating sulphides.

Flotation applied to Silver Ore.—The *Mining and Scientific Press* for July 24 contains an article describing the application of flotation in the treatment of ore at a Mexican mine containing silver sulphide, gold, galena, chalcopyrite, etc.

Marcy Ball-Mill.—The *Engineering and Mining Journal* for July 24 describes the Marcy ball-mill.

Precipitating Copper from Solutions. — In the *Mining and Scientific Press* for August 7, W. L. Austin writes of the advantages of sulphuretted hydrogen as a precipitant of copper after leaching.

Arizona Copper Co.'s Smelter.—The *Mining and Engineering World* for August 7 contains a description, written by C. A. Tupper, of the mechanical plant for transporting ore, fuel, etc., at the smelter of the Arizona Copper Co., at Clifton, Arizona.

Platinum Assay.—In the *Mining and Scientific Press* for August 14, F. A. Crampton describes his method of platinum assay as applied at the Boss mine, Nevada.

Copper Losses in Slags.—In the *Engineering and Mining Journal* for August 7, Frank E. Lathe, chief chemist for the Granby company, commences a series of three articles on metal loss in copper slags.

Tennessee Zinc.—In the *Engineering and Mining Journal* for August 14, Frank L. Nason discusses the occurrence and origin of zinc deposits in Tennessee.

Zinc in Wisconsin.—H. C. George commences a series of articles in the *Engineering and Mining Journal* for August 21, describing the operations in the Wisconsin—Illinois—Iowa district.

Potash in Chile.—In the *Engineering and Mining Journal* for August 7, Severo Salcedo describes potash deposits in the province of Tarapaca, Chile.

West Shining Tree.—In a note on the quartz veins at Porcupine in the *Bulletin* of the Canadian Mining Institute for June, J. B. Tyrrell cites evidence showing metasomatic replacement by quartz of the greenstone fragments between the ovoids of pillow structure, as bearing on the origin of the quartz in both districts.

Engels Copper Mine.—In the *Mining and Scientific Press* for July 31, Thomas T. Reed describes the Engels copper mine in Plumas County, California. The ore at this mine is to be treated direct by flotation without any preliminary mechanical concentration.

Potosi, Bolivia.—In the *Mining and Scientific Press* for July 24, Francis Church Lincoln describes the Potosi tin-mining district of Bolivia.

Tasmanian Complex Sulphides. — Apropos of Loftus Hills' report on the possibility of beneficiating the Tasmanian complex sulphide deposits by flotation, the *Mining and Engineering Review* for July describes the properties of the various proprietary companies, the nature and extent of the ores, and previous attempts to work them.

Origin of Rand Gold.—The *South African Mining Journal* for July 17 commences the republication of a paper by E. H. L. Schwarz, read before the South African Association for the Advancement of Science, describing the various theories relating to the origin of gold on the Rand.

Rand Water Supply.—At the July meeting of the South African Institution of Engineers, W. Ingham, chief engineer to the Rand Water Board, delivered a presidential address, taking for his subject the water-supply of the Rand.

Burma Mines Railway.—The *Engineer* for August 27 describes the long bogie-wagons built for the Burma Mines railway which connects the Bawdwin lead-zinc-silver mines with the Burma railways. The gauge of the line is 2 ft., the inside width of the wagons is 5 ft. 6 in. and the inside length 25 ft.

NEW BOOKS

The Cyanide Handbook. By J. E. Clennell; 2nd edition. Cloth, octavo, 600 pages. New York and London: McGraw-Hill Book Co. Price 21s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

Since the appearance of the first edition of 'Clennell's Handbook,' which was reviewed in the Magazine for September 1910, many changes in cyanide practice on gold and silver ores have been introduced and further knowledge has been gained as to the reactions which occur. The author has brought the book up to date on these matters, and has maintained its high standard. The increased size of the book represents, not merely 80 pages of added matter, but some re-arrangement and revision. The new edition will prove valuable to both the cyanide man and all who are interested in the general treatment of gold and silver ores. An important feature of the handbook lies in the fact that it deals, in addition to the cyanide process as such, with all matters connected with the cyanide industry, including the manufacture and use of cyanide, the preparation of the ore for treatment, the handling of the pulp and solutions, the precipitation of the gold, the treatment of the precipitate, and the production of the bullion. The important section, part vi., referring to special modifications introduced or suggested during recent years, especially in connection with refractory ores, will be found of particular value. G.T.H.

The Rare Earth Industry. By Sydney J. Johnstone. Cloth, octavo, 150 pages, illustrated. London: Crosby Lockwood & Son. Price 7s. 6d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

The publishers of this book are to be congratulated on the inauguration of a new series of works dealing with the principles of applied chemistry. We have been content for too long a time with translations of German books on chemical technology. The responsibility now lies with English chemists to provide reliable home-grown literature. The new series is under the general editorship of Geoffrey Martin. The author of the first of the series is on the staff of the Imperial Institute, and much of the information published by the Institute in connection with the rarer metals has been collected by him. A chapter on the industry of radio-active substances has been written by Alexander S. Russell. The chief headings of the book relate to the industries centering round the metals and compounds of the thorium-cerium, titanium, zirconium, tantalum-niobium, tungsten, vanadium, and uranium-radium groups, and special chapters are devoted to the manufacture of incandescent gas mantles and to the production of metallic filament lamps. The information includes both the scientific and commercial, and the bibliographies and references to authorities give additional value.

The World's Supply of Potash. Pamphlet, 50 pages. London: The Imperial Institute. Price 1s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

This pamphlet describes the sources of potassium salts: the mines in Germany and elsewhere, salt lakes, sea-weed, and plants, and the insoluble potash minerals. Owing to the war the chief source, the Stassfurt deposits, is cut off, and other sources are being revived or investigated. Reference to this pamphlet is made in our editorial columns this month.

Petroleum and Natural Gas Resources of Canada. Paper covers, octavo, 400 pages, illustrated. Ottawa: Canadian Department of Mines.

In 1912, the Canadian Department of Mines asked F. G. Clapp, of Pittsburg, Pennsylvania, to prepare a monograph on petroleum and natural gas with special reference to Canada. Mr. Clapp, with his assistant, L. G. Huntley, spent some time in the Canadian petroleum districts, but he did not complete his report, leaving for China on private business. The work was subsequently delegated by Mr. Clapp to a number of other petroleum experts in the United States, David T. Day having the general responsibility. The completed report was delivered to the Department of Mines in December 1913, but as it contained many statements that required correction or modification, it became necessary, in the absence of Mr. Clapp, to hand the manuscripts to Dr. Alfred W. G. Wilson for further advice and modification. Hence the delay in issuing the report. The work consists of two volumes, the first dealing with the technology of petroleum and natural gas, and the methods of exploitation, and the second with the general description of occurrences throughout the Dominion. Of the two volumes only the first has as yet been published.

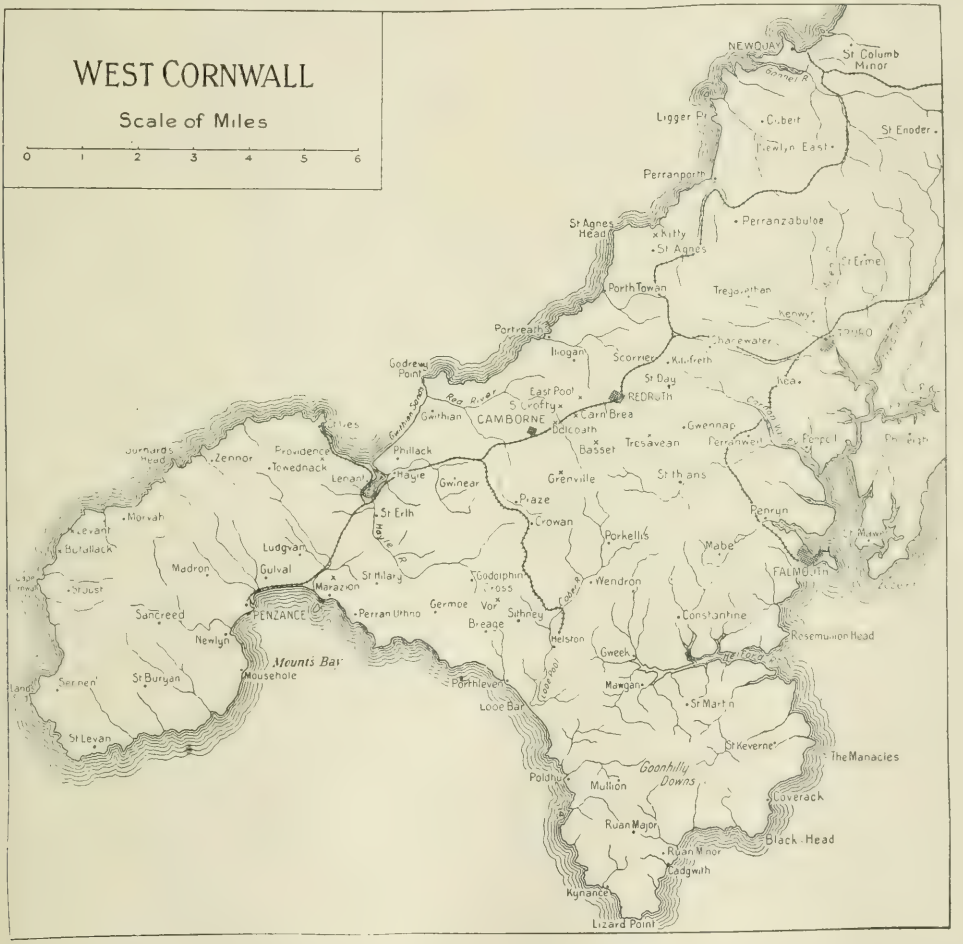
The Bituminous Sands of Northern Alberta. By S. C. Ells. Paper covers, octavo, 120 pages, with many illustrations. Ottawa: Government Department of Mines.

We have on previous occasions referred to the discovery of tar sands or bituminous sands in Northern Alberta, and have published an outline of the prospecting work done. This report gives a complete and unbiassed report on the occurrences, giving credit to the descriptions of the country by older geologists. Though the report is officially entitled as "preliminary," the information contains great detail.

COMPANY REPORTS

Dolcoath Mine.—As we have recorded on several occasions during the last three years, the premier tin mine of Cornwall has suffered from impoverishment in depth, and since the commencement of the war the depletion of the staff of miners has added to the anxieties. The report for the first half of the year 1915 shows rhat 42,676 tons of ore was raised, and 678 tons of tin concentrate extracted. These figures compare with 48,058 tons and 710 tons during the second half of 1914, and 60,631 tons and 868 tons during the second half of 1912. The yield of tin concentrate per ton of ore was 35·6 lb., as compared with 33·1 lb. during the previous half-year. The income from the sale of concentrate was £65,248 as compared with £59,672, the average price per ton of concentrate was £96. 2s. 8d. as compared with £83. 18s. 7d., and the income per ton of ore 30s. 6d. as compared with 24s. 10d. The working cost was £54,016, as compared with £55,058, and the gross profit £9985 as compared with £7360. Out of the profit, £4349 was paid as lord's royalties, and £2492 was allowed for depreciation, leaving a balance of £3143, which was carried forward. No dividend has been paid since the latter half of 1913, when a distribution of 2½% for the half-year was made. R. Arthur Thomas, the manager, reports that developments at depth from the Williams vertical shaft continue to be disappointing. The largest proportion of the ore is obtained from the Eastern section, and both here and in the Harriett section the prospects are encouraging.

Grenville United Mines.—This company was formed in 1906, under limited liability laws, to acquire the Grenville tin mines, situated to the south of Camborne, that had previously been worked on the cost-book system. The manager, Henry Battens, was able to obtain excellent results in spite of water troubles, and for some years good dividends were paid. Two years ago the grade of the ore developed began to fall, so that the output of tin concentrate decreased. The war and the drop in the price of tin have recently added to the difficulties of management. The report for the first half of the year 1915 shows that the output has been maintained as compared with the latter half of 1914, and that owing to the price of tin having improved, a small profit has been made as compared with a loss of £3511. During the half-year, 23,210 tons of ore was raised and 315 tons of concentrate sold. During the preceding period the same tonnage of concentrate was obtained from 24,515 tons of ore raised. The income from the



sale of concentrate was £30,759, as compared with £26,003. After all expenses were paid, £234 remained as balance of profit. Operations were restricted owing to the scarcity of miners. To cope with this scarcity of labour, hammer-drills have recently been introduced. Developments in the 375-fathom and 355-fm levels east of Fortescue's shaft have been encouraging, and the shaft below the bottom level is being sunk through profitable ore. On the other hand the ore-shoot west of Fortescue's shaft has proved to be of lower grade than was expected.

Weardale Lead.—This company was formed in 1883 to work a group of lead mines in Durham, at the head of the river Wear. The galena is found in the Carboniferous limestone, and it is associated with fluor-spar. The report for the year ended June 30 shows that 4169 tons of concentrate was produced and 574 tons purchased. At the smelter, 4647 tons was treated, and 3644 tons of pig lead extracted. At the Boltsburn mine the yield of concentrate was 3823 tons, at the Stanhopeburn 240 tons together with 6050 tons of fluor-spar, and at the Sedling 91 tons together with 3731 tons of fluor-spar. The accounts show an income of £70,339 from the sale of lead, and £3915 from fluor-spar. The net profit was £19,995, after £8026 had been paid for the ore purchased. Out of the profit, £9791 was distributed as dividend, being at the rate of 10%, £4800 was written off property account, and £2000 was applied to provide for the depreciation of investments, which stood at £38,168 in the balance sheet. The developments at the mines have continued to be favourable.

Sissert.—This company was formed in 1912 to acquire the share capital of a Russian company, called the Sissert Mining District Co., owning an estate in the Ural Mountains, south of Ekaterinburg, containing copper, iron, gold, and platinum mines. Details of the ore deposits were given in our issue of June 1912, and the process for treating the oxidized ores was described in our issue of January 1910. The report for the year ended May 1914 shows that 30,939 tons of copper ore was raised, averaging 3·9% copper, and that 22,731 tons of ore was smelted for a production of 730 tons of copper. In the leaching plant 81,293 tons of ore yielded 243 tons of copper. In addition 3307 tons of cupriferous pyrite averaging 3·87% copper was delivered to the sulphuric acid plant. At the iron mines 32,762 tons of ore was raised, and the product of the smelter was 16,419 tons of pig iron. The output of gold was 2171 oz., and of platinum 424 oz. The output of copper was less than during the previous year owing to smelting operations being suspended for three months while the furnace was rebuilt. Most of the ore was obtained from the Sysselsky mine, at which the reserve is estimated at 68,500 tons averaging 4¼% copper, as compared with 96,700 tons averaging 4½% copper the year before. The leaching ore is obtained from the Gumeshevsky mine, where recent development work has maintained the reserve at a 6 years supply. It was not possible to resume leaching this spring at the Gumeshevsky, owing to the Russian government requisitioning the sulphuric acid, but the latest news is to the effect that sufficient acid is now being allowed. The most important work done at present is the prospecting and development of the Degtiarsky orebody. We have on several occasions lately given reports on the progress of this work. The engineer, William Selkirk, estimates the proved reserve at 2,400,000 tons, averaging 3% copper and 3s. per ton in gold and silver, and in addition 700,000 tons of probable ore. Two shafts have been sunk 150 ft. to work this orebody, and cross-cuts are being driven. The accounts of the Russian company show a profit of only £4344, as compared with £43,885 the year before, and the English company is not able to pay a dividend, as compared with a distribution of £37,750 or 5%. During the year, loans have been obtained to the extent of £11,450, which has been advanced to the Russian company, making the total indebtedness £75,600.

Esperanza Sulphur & Copper. — This company was formed in 1906 to acquire the Esperanza, Forzosa, and Angostura pyrite mines in the south of Spain. T. D. Lawther is general manager. The capital is £350,000, and there are £47,020 out of £100,000 debentures outstanding. Small dividends were distributed for the years 1908 to 1912. The report for the year 1914 shows that the output was greater than during the previous year, when stoppages occurred owing to floods and shaft-repairs, but on the other hand deliveries could not be made to French and Belgian buyers after the outbreak of war. At the Angostura mine 47,426 tons was raised, and at the Esperanza-Forzosa group 63,497 tons. The reserves are estimated at 340,000 tons and 483,000 tons respectively. Developments prove that the north orebody at the Angostura has narrowed to merely a stringer 120 ft. below the 4th level, and that the same condition obtains on the 6th level at Forzosa. Diamond-drilling and sinking are being continued in the hope that the orebodies will widen with depth. The shipments from the port of Huelva were 98,751 tons, a decrease of 20,107 tons as compared with 1913. The ore sold but not delivered amounted to 16,000 tons of cupreous pyrite and 48,000 tons of sulphur ore. The profit for the year was £10,821, out of which £2409 was paid as debenture interest and £4206 allocated to the redemption of debentures. The outstanding debentures are due to be redeemed in 1916, and as the company does not possess the necessary funds, an arrangement has been made to defer the date of redemption for two years, increasing the rate of interest from 5 to 6%. The board is to be reconstituted so as to give debenture holders a direct representation. The debentures were issued to the vendors on the flotation of the company.

Bell Reef Development.—This company was formed in 1910 to acquire a gold mine and plant in the Gwelo district of Rhodesia, a short distance to the west of the Globe & Phœnix. The control at first was with the Rhodesian Exploration and Development, but passed in 1912 to the Gold Fields Rhodesian Development Co. The ore contains arsenic and graphite, and the original metallurgical treatment, based on amalgamation and cyanide, had to be abandoned in favour of roasting and all-sliming. The new plant was started in February 1914. The report now issued covers the year ended March 31 last. The consulting engineer, H. A. Piper, states that many difficulties have been experienced in connection with the extraction, and that the roasting operation takes longer than was expected. Further advice is being requisitioned, and W. B. Blyth has gone from Kalgoorlie to make investigations. During the year under review, 34,202 tons of ore was treated for a yield of 16,978 oz. gold, worth £71,424. The percentage of recovery was 82, and the yield per ton 9·9 dwt. or 42s. The working cost was £60,096, or 35s. per ton. The cost per ton is greater and the percentage of recovery and the capacity of the plant less than anticipated; hence the desire for further advice. The development was restricted for financial reasons, and the reserve on March 31 was 53,070 tons averaging 10·8 dwt., as compared with 56,788 tons averaging 12·4 dwt. at the corresponding time the year before. The orebody has been proved on the 7th level to be 660 ft. long, averaging 9·4 dwt. over a width of 47 in. On the 8th level the orebody has so far been opened for 258 ft. averaging 10·3 dwt. over 38 in.; as the ground is treacherous development has been slow. On the 9th level there appears to be a junction of the lode with the intermediate reef, and the assay-values are high. The prospects of finding rich ore here are encouraging. The working profit for the year is carried forward. The company has a capital of £181,338, and £54,222 is owing to the Gold Fields Rhodesian Development Co. for money advanced. Owing to the metallurgical difficulties, it has not been possible to liquidate any part of this debt so far.

Willoughby's Consolidated.—This company was formed in 1894 to consolidate various land and mining interests in Southern Rhodesia, controlled by Sir John Willoughby and others. The control is now vested with the British South Africa Company. The only dividend paid was one of 5% in 1910. The capital is £700,314, and there are £230,700 debentures, of which £45,000 have recently been issued to the company's bankers as security for loans. The report for the year 1914 now issued shows that the company has continued to work the Eiffel Blue mine in the Hartley district, and that 15,391 tons of ore yielded 7706 oz. gold worth £32,210. Eight other mines were let on lease, namely, the Alice-Atlas, Blanket, Bonsor, North Bonsor, Borrow, Camelia, Great Umviga, and Trixie. The total yield of these eight mines was 8820 oz. from 53,186 tons, and the royalty accruing to the company was £1532. The company owns a large interest in undeveloped coal deposits in the Sengwe and Tuli districts, and holds large tracts of agricultural land. The accounts show that £9644 has been paid as debenture interest, and that the net profit, £9848, has been carried forward.

Golden Kopje Proprietary Mines.—This company was formed in 1912 by the Gold Fields Rhodesian Development Co. to acquire the Golden Kopje and Union Jack gold mines, in the Lomagundi district of Rhodesia. The deposits occur in the banded ironstone of pre-Cambrian age, and the orebodies are of lenticular shape with ill-defined boundaries. As recorded in our issue of August 1914, the metallurgical equipment consists of plant purchased from the Ayrshire mine further north. The report now issued covers the year ended March 31. From this it appears that the treatment plant, consisting of 60 stamps, 3 tube-mills, and Burt filters, started operations in July 1914. As regards the metallurgical plant, it was found that the Burt filters did not give good results, and rearrangements of the plant have been necessary. At the same time, the capacity of the plant is being increased from 10,000 tons to 12,500 tons per month, so that the working cost per ton may be decreased, this being necessary owing to the ore treated having a much lower assay-value than was estimated. H. A. Piper, the consulting engineer, reports that the stoping difficulties are great, owing to the softness of the ore and the country rock. It has been impossible to confine the stopes to the expected width, and as a shrinkage-stoping method is in use, sorting of ore from wall-rock cannot be done. From the commencement of milling until March 31, the ore treated was 62,512 tons, and the yield 12,969 oz., worth £53,662, or 17s. 2d. per ton. The working cost was £58,207, or 18s. 7d. per ton. The yield per ton was much less than expected, the fall being chiefly due to the large amount of poor ground mined with the ore, and also to the absorption of gold in a new plant, and the disappointing results of the filters. A more correct idea of the performance of the plant can be given by quoting the results from November to March inclusive, when 42,685 tons was treated for a yield of gold worth £44,846 or 21s. per ton, at a working cost of £39,517 or 18s. 6d. per ton. Little development

was done during the year under review, and the figures for the reserve on March 31 were 290,194 tons averaging 7·6 dwt. The net loss for the year, are shown in the profit and loss account, was £7965. In order to provide further funds for the new plant, it has been necessary to borrow £25,000 from the parent company, making the total loans £77,031. The issued capital is £448,568.

Toronto (Rhodesia) Syndicate.—This company was formed in 1912 to acquire the Toronto, Lucknow, and other gold-mining claims in the Umtali district of Rhodesia. The issued capital is £47,326, and there are £2250 debentures. Two shafts have been sunk on the Toronto property. The report for the year 1914, now issued, states that 427 ft. of development work was done, which brought the total footage to 3741. At the end of 1913 the west shaft had reached a depth of 101 ft., at which point it intersected the lode in the hanging wall. A cross-cut of 30 ft. to the north proved the lode to be 26 ft. wide, averaging over 9 dwt. On the foot-wall side, drifts 12 ft. in width were extended a total distance of 106 ft., and showed an average assay-value of 10 dwt. The new shaft 167 ft. west of the west shaft was sunk 60 ft., and will be deepened so as to allow a cross-cut to be put out to the lode. In the eastern section practically no mining work was done during the year. J. H. Jeffreys, the manager, calculates that the development in the west shaft should produce 7100 tons, averaging 35s. per ton, bringing the total estimated ore reserves to 24,335 tons, containing gold worth £33,022. A trial crushing of 343 tons at a neighbouring battery yielded gold worth £525. Mr. Jeffreys considers this trial as satisfactory, and reports that it shows the ore can be treated by the ordinary process of milling and cyaniding. Subsequently a further crushing of 340 tons has yielded £717. During the year 6% debentures were created to the extent of £5000, and of these £2250 were issued in order to provide funds for the development of the mine. Further issues have since been made to enable the continuance of mining operations and to provide for the erection of a battery. This battery is being erected on the mine, and should shortly be in operation. It consists of two Nissen stamps, suction gas-engine and plant, stone-breaker and cyanide plant, and is being laid out so as to allow of extension later on. Since the close of the year an adit has been driven 300 ft., and connected in April with the level driven from the west.

Robinson Deep Gold Mining.—This company belongs to the Consolidated Gold Fields group and owns a property in the central part of the Rand, being a 'second deep' below the Ferreira Deep and the eastern part of Crown Mines. Milling commenced in 1898 with 40 stamps, and subsequently 260 stamps were added. More recently, when the grade of the ore mined became lower, the tube-mill installation was increased and fewer stamps were used. The report for the year ended March 31 last shows that 639,408 tons of ore was raised, and after the removal of 8½% waste, 585,730 tons was sent to the mill. The number of stamps employed averaged 119, and the tube-mills 9. The yield of gold by amalgamation was 132,807 oz., and by cyanide 64,372 oz., a total of 197,179 oz., worth £827,214, being 6·7 dwt. or 28s. 3d. per ton milled. The working cost was £513,593, or 17s. 6d. per ton milled, leaving a working profit of £313,769 or 10s. 8d. per ton milled. The profits tax absorbed £24,987, and £11,563 was paid to the Miners' Phthisis Fund. The shareholders received £225,000, the dividend being at the rate of 22½%. The ore reserve was estimated on March 31 at 1,513,000 tons, averaging 6 dwt. per ton, and in addition 365,000 tons, averaging 6·1 dwt. per ton, is returned as probable ore. Owing to the limited area remaining for development, it will not be possible to increase or even maintain the ore reserve, and in future much of the ore will be mined immediately on development. Trouble has been experienced with two of the shafts, and the maintenance expenses in connection with them have been considerable. At No. 2 shaft, anxiety exists as regards possible collapses of ground, owing to the shaft passing several times through an irregular dike.

Mungana.—This company was formed in Melbourne in 1901, as a subsidiary of the Chillagoe Company, to acquire the Girofla and Lady Jane mines in North Queensland. Additional capital was raised by reconstruction of the company in 1912. The ore consists of mixed argentiferous lead and copper sulphides, with some oxides and carbonates occurring in bunches in limestone. For the last five years the mining operations have been confined to the Girofla mine, as the Lady Jane is inaccessible owing to an underground fire. The report for the year ended March 31 last shows that no ore has been raised since February 1914, owing to the closing of the Chillagoe smelter pending development of the Mount Mulligan coalfields. The war has still further postponed the prospect of marketing the company's products, and in consequence the mines have been closed. During the year the main shaft of the Girofla was sunk another hundred feet to 823 ft., and it was in ore for practically the whole depth of sinking. A level at 810 ft. was commenced, but it was not possible to do much development before the suspension of operations. The indications are that much ore will be found between the 710 ft. and 810 ft. levels. At the Lady Jane the policy of flooding the mine in order to extinguish the long-raging fire has been frustrated by an unusually dry season, and the level of the water in the mine is still 250 ft. below the surface, the same level as reported a year ago.

Block 14 Torrington.—This company was formed in 1911 as a subsidiary of the Broken Hill Block 14 company to acquire a wolfram and bismuth property in the northeast of New South Wales. Milling with 10 stamps was started in July 1913, and another 10 were added six months after. A slime plant was provided in May 1914 The report for the year ended March 31 last shows that on the outbreak of war the mine was closed, as the contract for the sale of concentrate was automatically suspended. The directors writing on May 12 considered the securing of a new market for wolfram as hopeful. During the four months of operation, 13,535 tons of ore was treated, and 56 tons of concentrate obtained, averaging 66·8% WO_3 and 3·33% bismuth. In addition 6 tons of concentrate was won from old residues. Just before the war it was decided to raise additional capital by assessing the 150,000 £1 shares for 1 shilling each, thereby obtaining £7500. The call on 62,760 shares was paid, and the shares on which the call was not paid are to be sold. Askin Nicholas is the manager.

Rayfield (Nigeria) Tin Fields.—This company was formed as the Rayfield Syndicate in 1910 by Oliver Wethered to acquire a number of alluvial-tin properties in Northern Nigeria. The capital of the syndicate was £10,000, afterwards increased to £20,000. In 1912 the company was reconstructed on a larger scale under the present name, with a capital of £400,007. B. H. Nicolson was manager during the first two years, and J. M. Iles has been in charge since. Dividends to the extent of £40,000 were paid during the year ended June 30, 1913, but almost immediately afterward the state of the finances of the company became such that an issue of £50,000 debentures was found necessary. Since then the fall in the price of tin and the war in the Cameroons have combined to decrease the output and the revenue. The report for the year ended September 30, 1914, now issued, shows that the output of tin concentrate was 598 tons, and that 572 tons was sold. The accounts show a loss on the year's work of £4533. In our issue of April last we quoted Mr. Iles' statement of mining progress. Since then another deposit of tin has been detected in the Delimi region.

The Mining Magazine

Scientia non habet inimicum nisi ignorantem.

EDGAR RICKARD, *Managing Director*. H. FOSTER BAIN, *Editor*. EDWARD WALKER, *Assistant Editor*.

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QUOTATIONS

of leading mining shares on the London Market.
Shares are £1 par value except where otherwise noted.
Quotations are given in shillings.

GOLD, SILVER, DIAMONDS:	July 1 1914	Sept. 1 1915	Oct. 1 1915
Rand:			
Bantjes	14	6	5
Brakpan	51	59	62
Central Mining (£12)	160	130	125
Cinderella	6	3	4
City & Suburban (£4)	52	42	41
City Deep	66	61	64
Consolidated Gold Fields	43	24	26
Consolidated Langlaagte	35	38	37
Consolidated Main Reef	18	20	20
Crown Mines (10s.)	120	77	77
D. Roodepoort Deep	17	15	14
East Rand Proprietary	33	22	22
Ferreira Deep	47	42	42
Geduld	23	32	33
Geldenhuis Deep	26	20	20
Gov't Gold Mining Areas	23	23	26
Heriot	55	55	57
Jupiter	5	5	6
Kleinfontein	24	22	23
Knight Central	8	7	12
Knight's Deep	35	25	25
Langlaagte Estates	20	17	18
Luipaard's Vlei	10	6	7
Main Reef West	7	6	7
Meyer & Charlton	115	101	106
Modderfontein B	89	106	110
Modder Deep	58	99	100
Modderfontein, New (£4)	263	230	307
Nourse	27	21	21
Rand Mines (5s.)	120	82	83
Randfontein Central	17	11	12
Robinson (£5)	57	28	28
Robinson Deep	33	22	21
Rose Deep	43	34	34
Simmer & Jack	12	8	8
Simmer Deep	1	1	2
Springs	11	26	25
Van Ryn	67	52	54
Van Ryn Deep	47	50	51
Village Deep	40	36	36
Village Main Reef	40	26	22
Witwatersrand (Knight's)	71	60	57
Witwatersrand Deep	48	30	34
Wolhuter	14	12	11
Rhodesia:			
Cam & Motor	19	12	14
Chartered	17	10	10
Eileen Alannah	11	6	6
Eldorado	18	9	9
Enterprise	9	4	5
Falcon	14	7	8
Giant	14	5	5
Globe & Phœnix (5s.)	32	27	27
Lonely Reef	27	20	20
Shamva	46	36	37
Wanderer (5s.)	3	1	1
Willoughby's (10s.)	7	4	4
Others in South Africa:			
De Beers Deferred (£2 10s.)	330	212	200
Glynn's Lydenburg	11	11	10
Jagersfontein	78	52	56
Premier Diamond Defer'd (2s. 6d.)	152	85	80
Sheba (5s.)	4	3	3
Transvaal Gold Mining Estates	37	34	32
West Africa:			
Abbontiakoon (10s.)	8	8	8
Abosso	14	8	8
Ashanti (4s.)	16	16	17
Broomassie (10s.)	2	½	½
Prestea Block A	15	9	8
Taquah	15	14	14
West Australia:			
Associated Gold Mines	7	4	4
Associated Northern Blocks	7	4	4
Bullfinch	6	6	6
Golden Horse-Shoe (£5)	43	41	39
Great Boulder Proprietary (2s.)	14	15	15
Great Boulder Perseverance	2	1	1
Great Fingall	9	2	2
Ivanhoe (£5)	50	43	44
Kalgurli	36	30	19
Sons of Gwalia	23	17	16
Yuanmi	3	2	2

* Denomination of shares recently changed from £5 to £10.

Gold, Silver, *cont.*	July 1 1914	Sept 1 1915	Oct. 1 1915
Others in Australasia:			
Blackwater	16	15	15
Consolidated Gold Fields of N.Z.	13	11	11
Mount Boppy	10	7	7
Mount Morgan	52	41	40
Progress	10	5	5
Talisman	33	21	21
Waihi	42	35	36
Waihi Grand Junction	25	21	21
America:			
Alaska Treadwell (£5)	162	136	130
Buena Tierra	15	10	10
Butters Salvador	20	15	15
Camp Bird	9	5	4
Canadian Mining	—	8	8
CaseyCobalt	13	6	5
El Oro	14	7	7
Esperanza	15	7	7
Kirkland Lake Proprietary	74	27	27
Mexico Mines of El Oro	97	70	64
Oroville Dredging	10	14	14
St. John del Rey	15	15	15
Santa Gertrudis	11	7	7
Tomboy	22	20	20
Tough-Oakes	28	6	7
Russia:			
Lena Goldfields	43	30	30
Orsk Priority	7	9	9
India:			
Champion Reef (2s. 6d.)	11	11	11
Mysore (10s.)	93	79	80
Nundydroog (10s.)	27	25	25
Ooregum (10s.)	23	22	23
COPPER:			
Anaconda (£10)	126	155	314*
Cape Copper (£2)	60	55	50
Chillagoe (10s.)	1	½	½
Cordoba (5s.)	6	2	2
Great Cobar (£5)	3	2	2
Great Fitzroy (5s.)	½	¼	¼
Hampden Cloncurry	27	27	28
Kyshtim	55	36	37
Messina (5s.)	15	14	14
Mount Elliott (£5)	55	57	55
Mount Lyell	23	21	22
Rio Tinto (£5)	1355	1100	1080
Sissert	25	20	21
South American Copper (2s.)	22	12	12
Spassky	52	39	40
Tanalyk	78	37	36
Tanganyika	40	24	23
LEAD-ZINC:			
Broken Hill:			
Amalgamated Zinc	28	22	25
British Broken Hill	36	19	19
Broken Hill Proprietary (8s.)	36	42	44
Broken Hill Block 10 (£10)	32	20	16
Broken Hill North	52	36	39
Broken Hill South	175	120	125
Sulphide Corporation (15s.)	26	17	17
Zinc Corporation (10s.)	19	11	12
Asia:			
Burma Corporation	28	33	31
Irtysh Corporation	—	32	32
Russian Mining	31	16	15
Russo-Asiatic	151	80	81
TIN:			
Nigeria:			
Bisichi	8	5	5
Jos (5s.)	5	4	4
Kaduna (5s.)	15	15	15
Naraguta	17	12	11
N. Nigeria Bauchi (10s.)	3	2	2
Rayfield	5	3	2
Ropp (4s.)	100	14†	13†
Other Countries:			
Aramayo Francke	31	26	27
Briseis	5	4	4
Cornwall Tailings	17	12	12
Dolcoath	11	6	5
Geevor (10s.)	5	1	1
Gopeng	27	26	27
Mawchi	20	4	5
Pahang Consolidated (5s.)	7	6	6
Renong Dredging	36	20	20
Tekka	55	55	57
Tronoh	26	31	30

† Denomination of shares recently changed from £1 to 4s.

METAL MARKETS

Copper.—A distinctly optimistic note has dominated the market, in strong contrast to the tendency of the previous months. Standard copper has advanced from £68. 5s. to £73. 17s. 6d. three months. The price movement synchronizes with the decision of the Government to permit the export of rough copper to the United States for conversion into electrolytic. Important parcels have been shipped for that purpose both from Liverpool and Swansea. It is expected that the present margin between electrolytic and standard will be lowered. Electrolytic has advanced with standard from £84 to £88 in this country, and from 17½c. to 18 to 18¼ in America. The volume of trade done is not considerable, but this is due more to the reluctance of sellers than to lack of demand. A strike of miners is reported from the Arizona district affecting an output of 3000 tons monthly. In refined copper the home market is quiet, but there is a stronger demand both from our Allies and in the United States. No general buying movement, however, has made itself felt. Consumption being what it is, this is probably not far off. The producers seem to be in command of the situation, and second bands are offering very little. Speculation is entirely absent.

Average prices of cash standard copper: September 1915, £69. 1s. 2d.; August 1915, £68. 15s. 1d.; September 1914, £52. 15s. 9d.

Tin.—The tin market has been uninteresting with little fluctuation in price, and no great movement in metal. Banca and Billiton brands are being withheld from the market, and leading interests do not favour a rise in price while the accumulated stocks are in the hands of the smelters. Trade all round is good, although the export from South Wales is curtailed by the war. America, however, is placing most of her orders in the Straits to the disadvantage of the London market. Export of Chinese tin is stopped, as the railway from Yunnan to Hong Kong is under repair. American deliveries have been excellent, and this is attributed to consumers laying in increased supplies on account of the difficulties in shipments from the East and London. Russian demand is good; 500 tons has been shipped direct from the Straits to Vladivostok. Italy has also bought well both from London and the Straits. Speculation is inconsiderable. The September statistics proved rather less favourable than anticipated. Shipments from the Straits amounted to 5300 tons, and are estimated for October at 5000 tons. The price closes at the lowest for the month at £150 cash, and £151. 5s. three months, a fall of about £5.

Average prices of cash standard tin: September 1915, £152. 18s. 4d.; August 1915, £151. 12s. 10d.; September 1914, no quotation.

Lead.—The position is entirely dominated by the scarcity of shipping facilities. Demand in this country has become spasmodic, and of course consumption except for war munitions has almost vanished. In spite of the falling off in demand, the lack of supplies has become acute. Scarcity of vessels has reduced supplies of foreign lead, and shortness of labour in this country is affecting the output of English lead. Large stocks of material are at works awaiting treatment. In consequence a heavy premium has been established for spot metal to meet the Russian demand before the close of navigation, and as much as £25. 10s. has been realized as against £23. 5s. for November and December. The Spanish output is largely finding its way to France and Mediterranean ports. Australian supplies have fallen off, and the Americans are not pressing their goods. It seems as if the present level of prices would continue for some time yet.

Average prices of soft foreign lead: September 1915, £23. 3s.; August 1915, £21. 18s. 11d. September 1914, £18. 16s. 3d.

Spelter.—This market has become narrow and difficult. There is no decided tendency and the situation in America is obscure with alternate bids and offers from them on this side. The increased production has not materially relieved the position. Japan has been supplying moderate quantities on this market, but has shown a disposition to re-purchase. Russia continues to purchase high-grade qualities largely.

Average prices of good ordinary brands: September 1915, £67. 17s. 9d.; August 1915, £67. 15s. 9d.; September 1914, £25. 14s. 9d.

Antimony.—The market for antimony continues to be purely nominal, and quotations are apt to be misleading. With this reservation we may give £110 as the price of English brands. Chinese crude is quoted at £65 to £70. The reopening of mines and smelting plants in the west of America continues. American producers receive many export inquiries and all available production will be readily sold.

Quicksilver.—The quotation of Spanish quicksilver remains steady at £16 per flask of 75 lb.

Platinum.—190s. per oz., nominal.

Bismuth.—10s. per lb.

Cobalt.—96 to 98% pure metal, 8s. per lb.

Cadmium.—7s. per lb.

Molybdenum.—The market for molybdenum ore is quiet and quotations have slackened slightly, about 95s. per unit being quoted for ore averaging 90% MoS_2. Ferro-molybdenum, 65 to 85%, 18s. per lb. of molybdenum contained.

Iron.—No. 3 Middlesbrough remains about 65s. per ton. Hematite is quoted at 105s. per ton and is in demand for France and Italy. Steel rails £9 2s. 6d., ship plates £10. Spanish ore has jumped during the month from 25s. to 31s. 6d., comparing with 18s. 6d. a year ago.

Tungsten.—This metal is now under Government control, and the price of ore is fixed at 55s. per unit of WO_3. Ferro-tungsten, 80 to 90%, 5s. 8d. per lb. of metal contained. Metallic tungsten 5s. 10d. per lb.

Aluminium.—Free supplies of this metal have become scarce, and quotations have soared beyond £200 per ton into the 'nominal' region. On the American market 45 to 50 cents per lb. is being asked. The Aluminium Corporation is intending to expand its works in North Wales.

Nickel.—No alteration has been made in the quotation of nickel, which remains at £225 per ton.

Chromium.—The quotations of chrome ore remain as given in our report last month: 105s. to 115s. per ton on the basis of 47 to 55% chromic acid. Ferro-chrome 4 to 10% carbon £28 to £32, basis 60%; specially pure less than 2% carbon £80 per ton.

Ferro-Vanadium.—33 to 40% vanadium, 9s. 6d. per lb.

Manganese.—Indian ores, 50%, are quoted nominally at 19d. and 20d. per unit, and Brazilian at 3s. per unit. The market is greatly restricted. Indian ores now go almost entirely to England and France, and the export of ferro-manganese from this country is largely controlled by the Government.

Silver.—The silver market has maintained the strength acquired a month ago, and the price per standard ounce, alternating from 23½d to 24d., has been higher than for six months past. Liberal purchases for the United States and British Governments have supported the market. Direct shipments of silver from San Francisco to China form an item of interest.

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,998	363,826	8,794,824	37,358,040
July, 1914	703,136	29,349	732,485	3,111,398
August	684,607	27,311	711,918	3,024,037
September	677,063	25,107	702,170	2,982,630
October	703,985	29,761	733,746	3,116,754
November	685,450	30,386	715,836	3,040,677
December	669,075	26,062	695,137	2,952,755
Year 1914	8,033,567	344,570	8,378,139	35,588,075
January 1915	689,817	25,167	714,984	3,037,058
February	653,213	23,008	676,221	2,872,406
March	727,167	26,768	753,935	3 202,514
April	717,225	26,855	744,080	3,160,651
May	737,752	25,796	763,548	3,243,347
June	727,924	27,356	755,280	3,208,224
July	742,510	27,845	770,355	3,272,258
August	749,572	29,191	778,763	3,307,975
September	749,235	27,515	776,750	3,299,423

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
July 31, 1914	167,006	9,257	13,656	189,919
August 31	168,851	9,485	—	178,316
September 30	169,619	9,389	—	179,008
October 31	170,438	9,212	—	179,650
November 30	166,039	8,990	—	175,029
December 31	164,650	8,704	—	173,354
January 31, 1915	172,331	8,675	—	181,006
February 28	180,422	8,494	—	188,916
March 31	185,239	8,216	—	193,455
April 30	186,941	8,418	—	195,359
May 31	183,961	8,857	—	192,818
June 30	184,155	9,019	—	193,174
July 31	190,026	9,371	—	199,397
August 31	196,866	9,943	—	206,809
September 30	204,833	9,743	—	214,576

Cost and Profit on the Rand.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Year 1912	25,486,361	29 2	19 3	9 11	12,678,095
Year 1913	25,628,432	27 9	17 11	9 6	12,189,105
January 1914	1,902,733	27 4	18 2	9 3	876,577
February	1,861,442	26 10	17 11	8 10	823,654
March	2,094,098	26 4	17 3	9 1	945,000
April	2,075,561	26 6	17 3	9 3	955,600
May	2,196,287	26 3	17 0	9 3	1,011,968
June	2,178,161	25 5	17 1	9 5	1,025,629
July	2,281,717	25 10	16 9	9 1	1,032,562
August	2,261,800	25 5	16 8	8 9	988,567
September	2,188,939	25 11	16 9	9 1	989,859
October	2,301,795	25 8	16 8	8 9	1,004,264
November	2,192,365	26 3	17 0	9 0	982,346
December	2,167,056	25 11	17 3	8 6	917,662
Year 1914	25,701,954	26 6	17 1	9 0	11,553,697
January 1915	2,237,748	25 10	17 5	8 3	920,194
February	2,077,792	26 4	17 11	8 4	867,782
March	2,366,392	25 9	17 4	8 4	985,511
April	2,289,002	26 4	17 5	8 9	996,846
May	2,416,966	25 8	17 0	8 6	1,031,220
June	2,346,493	26 1	17 2	8 8	1,017,908
July	2,395,397	26 1	17 4	8 7	1,027,332

The above are the official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 70% of the working profit.

Production of Gold in West Africa.

Year 1912	Year 1913	Year 1914	Aug. 1915	Year 1915
£1,497 ,179	£1,634,700	£1,727,044	£139,364	£1,148,497

Production of Gold in Rhodesia.

Year 1912	Year 1913	Year 1914	Aug. 1915	Year 1915
£2,707,368	£2,903,267	£3,530,207	£344,493	£2,517,578

Gold Output of India.

Year 1912	Year 1913	Year 1914	Sept. 1915	Year 1915
£2,265,094	£2,299,315	£2,340,259	£195,952	£1,773,632

Production of Gold in Western Australia.

	Export oz.	Mint oz.	Total oz.	Total value £
Total, 1913	86,255	1,227,888	1,314,143	5,582,140
July, 1914	8,294	88,305	96,599	410,324
August	101	102,346	102,447	435,164
September	1,535	103,577	105,112	446,485
October	2,028	99,366	101,394	430,692
November	1,217	109,282	110,499	469,387
December	1,214	101,534	102,748	476,253
Total, 1914	51,454	1,181,520	1,232,974	5,237,308
January 1915	561	98,196	98,757	419,495
February	607	103,661	104,258	442,900
March	1,829	91,872	93,764	398,282
April	1,017	101,592	102 609	435,853
May.	2,311	101,359	103,670	440,360
June	1,273	100,036	101,309	430,333
July	555	98,859	99,414	422,271
August	1,079	99,941	101,020	429,103
September	2,019	100,833	102,852	436,885

Other Australian Gold Production.

	1913	1914	Sept. 1915	1915
	£	£	£	£
Victoria	1,847,400	1,740,300	138,900	1,055,400
Queensland	1,118,610	1,011,310	79,470	807,810

Exports of Copper from United States

(Reported by United States Customs).

Month	Long Tons	Month	Long Tons
July, 1914	34,145	March, 1915	29,725
August	19,676	April	20,481
September	23,866	May	25,785
October	28,995	June	15,751
November	20,170	July	16,812
December	16,830	August	16,289
January, 1915	28,197	September	14,327
February	12,066		

Nigerian Tin Production.

In tons of concentrate of unspecified content.

Year 1912 tons	Year 1913 tons	Year 1914 tons	Aug. 1915 tons	Year 1915 tons
2,532	5,032	4,832	438	3,288

Production of Tin in Federated Malay States.

Estimated at 70% of concentrate shipped to smelters.

1911 tons	1912 tons	1913 tons	1914 tons	Aug. 1915 tons	1915 tons
43,967	48,250	50,128	49,042	4,046	31,908

Sale of Tin Concentrate at Redruth Ticketings.

	Tons	Value	Average
Year 1911	6151¼	£702,599	£114 4 5
Year 1912	6492	£831,908	£128 5 6
Year 1913	6186	£744,268	£120 2 6
Year 1914	4987	£432,437	£86 14 3
January to June 1915	2826	£261,958	£92 13 10
July 5	202	£18,721	£92 13 5
July 19	204½	£18,102	£88 10 5
August 3	177	£15,069	£85 2 9
August 16	171	£14,098	£82 9 0
August 30	156	£12,935	£82 18 5
September 13	149	£12,554	£84 5 1
September 27	171½	£14,459	£84 6 3

Imports of Tin Concentrate into United Kingdom.

	September		Year 1915	
	Tons	Value	Tons	Value
		£		£
South America	1,279	96,675	26,635	2,235,325
Other Countries	1,006	96,993	7,254	675,678
Total	2,285	193,668	33,889	2,911,003

REVIEW · OF · MINING

Introduction.—Financing the war has absorbed so much attention in the last month that little has been left for technical matters in mining. The American loan, which was one of the greatest transactions in America's financial history, is at the same time a great testimony to the credit of the Allies in a neutral country. It went through smoothly and did not disturb the American demand or rate for money, which speaks well for the soundness of American conditions. Another index of better things in the United States is the growth of the figures of "unfilled orders" reported by the Steel Corporation. This is all the more significant because that great company has not gone directly into war work. In Europe, necessarily, we must wait till the end of the war for better industrial conditions. Just now in London impending new taxes centre attention. We discuss elsewhere the profits tax and gold mines. The Spelter Committee is still discussing matters, and it is rumoured that a recommendation favourable to a bonus is to be made. We regret to say that we fear historians will be busy with the "late" war before anything very definite or practical results from official action as to spelter. Australia will do something, and with individual action here in the United Kingdom a change may be accomplished, but we are not hopeful of official help either by bonus or tariff. After the war there will be a glut of spelter and to what extent the Zinc Convention will again become powerful can hardly be foretold. The close relations hitherto subsisting between various metal companies was brought out in the decision of the Prize Court not to allow to Henry R. Merton & Co. the £5000 paid as advance freight on a cargo of zinc concentrates seized and admitted to be enemy property. Messrs. Merton claimed to have merely acted as bankers for Metallgesellchaft, but the Court held that the firm was more deeply implicated. Failure to produce certain letters seems to have counted heavily against it. We are sorry to see any old and well known firm in trouble. The situation is a difficult one for many metal dealers since, up to the opening of the war, the metal trade was frankly international and the great firms were jointly owned by the nationals of the several countries. That may or may not have been a good thing for the industry, but there was no mystery or deceit about it. It is difficult to readjust such conditions instantly, and probably after the war trade will to a large extent flow back into old channels. In the meantime, however, each resident group is under the most severe obligations to be loyal beyond the possibility of suspicion to the country in which it is.

Transvaal.—The output of gold on the Rand during September was 749,235 oz., and in the other districts 27,515 oz., making a total of 776,750 oz., worth £3,299,423, as compared with 778,763 oz. worth £3,307,975 in August. The number of natives employed in the gold mines on September 30 was 204,853, as compared with 196,866 on August 31, and 169,619 on September 30, 1914. A glance at the figures given on our page of statistics will show that the recovery in the labour position has been continuous recently.

The Barnato group of gold mines is in excellent condition at present; progress is uninterrupted at the principal mines and the outlook is promising. The Consolidated Langlaagte is doing so well that the debenture debt is being reduced at a greater rate than was originally arranged, and at the same time the dividend has been increased. Knights continues to make excellent profits. Van Ryn Deep is likely to be one of the most successful mines on the Rand. We have recently recorded that at the Government Gold Mining Areas (Modderfontein) the treatment plant is to be doubled, and that financial arrangements have been made with this object. During the year ended June 30, the Barnato group of mines produced gold worth £3,622,207, while

£999,460 has been distributed as dividends.

The splitting of the shares of the New Modderfontein from the denomination of £4 to the more usual £1 is proposed by the directors, and the matter will be discussed at a meeting of shareholders to be held in January. This denomination was originally adopted for the convenience of the French market, where 100 francs is the normal denomination. The City & Suburban has a £4 share, the Robinson one of £5, Central Mining £12 (reduced from £20), Crown Mines 10s., and Rand Mines 5s., but £1 is the standard on the Rand.

The dangerous state of the hanging wall at Village Main Reef continues to be the cause of accidents. On September 28 a fall of ground killed three natives and severely injured eight. The official report states that the Main and Inclined shafts crushed between the 9th and 10th levels, and that all the timbers collapsed. If the fall had occurred half an hour earlier hundreds of lives would have been lost. The resulting tremors on the surface were the most serious in the history of the Rand. For several years the Village Main Reef and the adjoining Ferriera Deep have been the centres of much disturbance. This latest accident naturally accentuates the necessity for the present Commission on Earth Tremors to make useful suggestions at as early a date as possible.

The directors of the Geduld have decided to proceed forthwith with the expansion of the metallurgical plant, by the addition of stamps and tube-mills, that will increase the capacity from 24,000 to 40,000 tons per month. The company has sufficient funds to pay for the plant, so that no new issue is necessary.

In June last we gave a gloomy report of developments at Knight Central, a deep level in the east Rand that has given little return to shareholders. This month quite a cheerful cable came to hand, for where the Main Reef has been intersected on the lowest level, No. 17, below the dike, the sampling gave 21·9 dwt. over 40 in. In the level above, the assays showed only 1·5 dwt. over 48 in. It remains to be seen whether the better result will be maintained, but in the meantime the shares have received much notice in the markets of London and Johannesburg recently.

Rhodesia.—The output of gold during August was worth £344,493, the highest monthly figure yet recorded, the previous best having been £337,241 in October last. The most notable factor of the increase in the figures is Golden Kopje, which jumped from £8743 in July to £15,411 in August. Last month we referred in some detail to the many adverse circumstances at the mine, and showed that the ore as sent to the mill is unavoidably diluted with the wall-rock, which it is impossible to remove by hand-picking. As the yield per ton in August was 30s. 9d. as against 14s. 6d. in July, special efforts are evidently being made to improve the conditions of mining.

Experts are gathering in London for the trial of the Globe & Phœnix—Amalgamated Properties case involving extra-lateral rights, to which we have previously referred. The hearing is to begin on October 19, and among those present will be Messrs. H. A. Piper, C. B. Kingston, Francis Drake, Walter Currie, A. H. Ackermann, S. C. Dyer, and H. Ewer Jones.

West Africa.—The output of gold in West Africa for August was worth £139,364 as compared with £140,290 for July. Abosso and Prestea Block A showed some improvement, but the Abbontiakoon and Broomassie figures were lower.

Last month we referred to the depressed conditions in Nigeria caused by the war. This is further exemplified by the fact that the Niger company reports a financial loss for the year 1914 of £31,072. This company was in 1886 invested with a Royal Charter, and had governmental duties as well as trading interests. In 1900 the charter was surrendered. Since that date the company has been a prosperous business enterprise, paying dividends of 10% or more for each year from 1901 to 1913, besides dividends on preference shares and interest on debentures. The effect of the war is made obvious by these figures.

Australasia.—A discovery of a deposit of manganese ore has been made at Pernatty Lake in South Australia. The deposit is near the new trans-continental railway, and is about 75 miles west of Port Augusta. Bulk samples indicate a high grade, the constituent of

MnO_2 being 80%. A company, called the Australian Manganese Co., has been formed for the purpose of developing the property.

Broken Hill lead now finds an outlet in Russia, and the Proprietary company records that during the half-year ended May 31 last 1450 tons was delivered to Vladivostok to the order of the Russian Government. For the management of this deal, Mr. J. B. Suttor, the Commercial Commissioner for New South Wales in the Far East, deserves a large share of credit. He is a real trade consul.

The main orebody of the Kalgurli mine has been proved finally to terminate between the 1750 and 1850-ft. levels, and development in depth during the last year has not added to the reserve. Attention has therefore been turned to the upper levels. Sufficient ore is blocked out to keep the mill going for at least a year, but judging by the report of the manager, Mr. R. S. Black, operations will last longer than this. The grade of the ore to be treated is lower than before, and the profits will be accordingly less. During the year ended July 31, 125,990 tons of ore was treated yielding gold worth £249,878. The mine has an excellent record, for £3,854,569 has been extracted from 1,474,280 tons, and £1,540,500 has been distributed as dividend, on a nominal capital of £120,000.

Cornwall. — As recorded on many occasions recently, the scarcity of labour has caused a restriction of mining operations in Cornwall, and in consequence the output of tin has been reduced. The figures given in our page of statistics show that the amount of black tin sold at each of the fortnightly ticketings since the end of July has been less than 200 tons. At the sales held on September 13, the amount offered was only 149 tons.

The results of the last quarter's work at the Levant mine were discouraging, for though 116 tons of tin concentrate was sold for the sum of £10,125, and small amounts were received from copper and arsenic, the cost of working was greater than the revenue by £1710. The renewal of the leases receives keen attention, and a decision must be made without delay as to whether the present company shall continue mining or relinquish the property. This matter has been debated continuously for the last two or three years. Mr. Freethy Oats, the chairman, and his father, Mr. Francis Oats, of De Beers fame, have put much money into the mine, and their personal opinion is that the mine should be abandoned. The Bolitho family are still largely interested in the company, and possibly by their efforts a stoppage may be obviated.

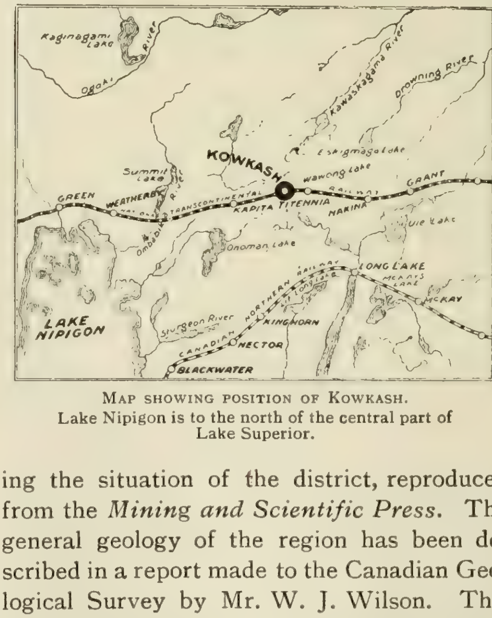
The dredging propositions are under a cloud at present. The Cornish Tin Sands company suspended operations at the beginning of the war, and a petition for the compulsory wind-up of the company presented by a firm that supplied most of the plant is to be heard by the Bankruptcy Court during the current month. This company was organized by Mr. Oliver Wethered for the purpose of re-treating the sands on Gwithian beach at the mouth of the Red river, and if financial and economic conditions had been as favourable as they were on the flotation of the company the present position would not have been so embarrassing. Another company that was started under similar favourable conditions is the Carnon Valley. This company was formed by the Baillieu group, which operates the Cornwall Tailings Co., to reclaim tailing discharged into the river above Restronguet creek, a branch of Falmouth harbour. Mr. T. J. Hoover is chairman, and has taken keen interest in the methods of dredging, re-grinding, and concentrating. Unfortunately the low price of tin and the difficulty of securing efficient workmen have prevented the success of the venture, and the plant has been closed.

The beneficiation of tin tailing is not the most attractive project in the metallurgical world, as may be gauged by the fact that the Cornwall Tailings Co. recovers only 27% of the estimated content in the material treated. During the last complete year for which statistics are available, the company handled 144,460 tons of tailing from the Carn Brea dumps, and extracted 432 tons of concentrate, selling for £31,724, out of which only £1135 was profit.

The Cornish Post announced October 2 that Mr. A. F. Basset had sold the Tehidy estate, including mansion, park, and mineral rights, to Mr. Robert Hamilton Edwards. Mr. Edwards was at one time managing director of the Amalgamated Press, the organization owning the weekly and monthly publications of the Harmsworth or Northcliffe group. This time the announcement of the sale of Tehidy is not a rumour, but an actual fact. Curiously enough, Mr. Thomas has often been called the Cornish Harmsworth. The Basset family have owned this estate for 800 years, and have held the mineral rights at Dolcoath, part of Carn Brea and Tincroft, South Crofty, and East Pool. Since the formation of the present Dolcoath company 20 years ago, no less than £170,000 has been paid by the company to the estate. The dues are not calculated on profits, but on the value of the gross output. For instance at Dolcoath, one-fifteenth is paid when black tin is over £60 per ton, the fraction decreasing proportionately as the price becomes lower, until it is one-thirty-fifth when the price is below £35. As it would not pay to work the mine nowadays with black tin even at £60, this sliding scale is obviously out of date. Mr. Basset has always been loth to help the mining community. The new owner is already showing a more sympathetic attitude. He is ready to sell on reasonable terms the mining rights of active or idle properties, and he intends to provide some part of the funds required for still further exploring at depth at Dolcoath.

India.—Exploratory work is being continued by the Mysore Southern Extension Syndicate with a view of testing the ground outside the southern boundary of the Mysore mine by means of workings started from the lower levels of the Mysore. Some encouraging results have recently been obtained. On the 2385-ft. level the lode is at present 3 ft. wide and assays 15 to 25 dwt. per ton. In a rise from the 2160-ft. level the ore is 4 ft. wide assaying 32 dwt. At the other end of the Kolar goldfield, the Balaghat has attracted notice owing to good developments at depth. During the last few years we have frequently referred to the disappointing results at this mine, and have recorded that the directors and shareholders have unanimously favoured a continuance of prospecting at depth. The reports recently received afford encouragement. On the 2700-ft. level, ore varying from 22 dwt. over 4 ft. to 15 dwt. over 7 ft. has been disclosed in the south drift; and in the northern workings on the same level a cross-cut shows 2 oz. over 15 in. Arrangements are in hand for sinking below the level, and additional hoisting plant has been ordered.

Canada is excited by a new gold discovery in Western Ontario, and has been enjoying the excitement of a gold rush. Enjoying is a term properly used this time, as the discovery lies barely 20 miles north by canoe from the new main trans-continental railway, the Grand Trunk Pacific. The Argonauts travel therefore in Pullman trains and have all the luxury of sleeping and dining cars en route. We present below a sketch-map show-



Map showing position of Kowkash.
Lake Nipigon is to the north of the central part of Lake Superior.

ing the situation of the district, reproduced from the *Mining and Scientific Press*. The general geology of the region has been described in a report made to the Canadian Geological Survey by Mr. W. J. Wilson. This has been summarized by the *Canadian Mining Journal* for September 15. With his usual enterprise Mr. W. G. Miller, provincial geologist for Ontario, promptly took steps to secure accurate knowledge of the new discovery, and to aid the prospectors in the district by detailing Mr. Cyril G. Hopkins to it. As a result we are privileged to present the following cable received on October 11: "Hopkins reports officially to Ontario Bureau of Mines that the geology of Kowkash is like that of Porcupine and Kirkland Lake. At the time of his visit one vein five inches wide and uncovered 40 ft. contains gold of spectacular nature. Other veins are reported." All this is very encouraging, as another Porcupine would be worth having. The region is one mainly of Keewatin rocks, and from the reference to Porcupine we infer that the ores are probably related to Algoman intrusives and Temiskamian inliers. The region is covered with glacial clays and forests. Rock exposures are not numerous, erosion has been profound, and the finding of such gold veins as remain is in the first place somewhat a matter of chance. But that there are rich veins still to be found in unexplored Ontario is the settled belief of those who know the area, and Kowkash is a case in point. Other Canadian districts are discussed in our Toronto letter.

Alaska. — Southwestern Alaska has attracted more attention than usual this year, possibly as an incidental result of the railroad building further east. The Coast and Geodetic Survey reports that with work completed this year steamers drawing 14 ft. can go up the Kuskokwim river as far as Bethel. Most of the miners from that little city went this summer to Canyon Creek. While reports are not yet in great hopes are held since four men working there in 1914 won $17,000. This year 75 men have been at work, and an output of 3000 oz. gold is anticipated. Lack of lumber will prevent anything more elaborate this year than ground sluicing on certain of the claims. On Aralik river a Bayley scraper and shovellers are at work. On Bear creek, a tributary of Tuluksak river, the Eskridge syndicate expects to have a dredge at work by next year. On Aniak river two or three parties are working on a small scale. George river, which empties into Kuskokwim at Georgetown, which was 'stampeded' in the winter of 1910-11, and was condemned, is now producing. One party with a hand windlass took out a dump last winter, and had gravel which ran as high as $8 to the bucket. On Candle creek, a few miles below Takutna, there is ground that yields $20 to the cubic foot. Much of this is too deep for hand work, and must wait until a dredge can be erected. This summer 45 men are employed. Some men are working on More creek, a tributary to Takutna, and there are a number of tributaries which have good prospects and promise to be producers in the near future. McDonalds and Beetles quartz mine near Kolmakofsky is 'bonded' to Iditorod capitalists for $200,000. The work of opening the big quartz mines near Juneau goes forward steadily. Alaska Gold Mines reports the ore as milled to run about $1·50 per ton and all costs to come within 65c. At the Alaska-Juneau about one year's work is necessary to bring the mine up to a capacity of 8000 tons per day. The bottom levels of the Treadwell mines are looking well, and experimental work looking toward cheaper milling at both properties is under way.

United States.—In California attention has been centred on the Exposition, which is proving a financial as well as artistic success, and the meetings of the various engineering societies of which more later. Plymouth Consolidated continues to do well, and reports that at the Montezuma, a neighbouring property under option to the Plymouth, 4 ft. of 9 dwt. ore was found at 500 ft. On advancing 8 ft. the ore assayed 12 dwt. There is an excellent prospect of the company making a second mine here. In Colorado, the Yak tunnel at Leadville, it is reported, will be extended to the Aladdin property near the head of Big Evans gulch. Cripple Creek keeps up its production, and Cresson Consolidated seems again to be in rich ore. At Butte in Montana the pay roll for July was the largest in the history of the mines, amounting to $1,700,000. As the men are paid there on a sliding scale dependent upon the price of copper, this was true despite the fact that the output was not at a maximum. The August production of the Anaconda company was 22,800,000 lb. In the Coeur d'Alene region the purchase of the Northport smelter by the Day interests and the threat of opening it for custom business, attracts attention all the more keen because Mr. Harry L. Day is manager for the Guggenheim's at the same time that he and his brothers are heavy owners in the Hercules mine. At Joplin, Missouri, prosperity has got to be such a habit among mining men that they are taking small interest in the effort of the States Attorney to uncover a zinc trust. The Arizona Copper Co. reports that operations were entirely suspended on September 16 owing to labour troubles. No particulars are given, except that the cause of trouble is an unexpected dispute about wages.

Mexico.—The old adage that "no news is good news" fails to hold good as regards this turbulent North American republic. While there is little news direct from Mexico, that which comes by way of the United States is most depressing. Death by starvation has become almost as familiar as death by violence, to which we were already inured. There have been raids across the American border and several battles between detachments of United States troops and Mexicans, whether regulars or irregulars is not entirely certain. Several conferences have been held by the American governments looking toward peace in Mexico and the recognition and financing of some provisional government. With the exception of Carranza, the various chiefs seem to have agreed to withdraw if necessary, to secure peace. That implacable gentleman, however, refused to consider any possible termination other than one based upon recognition of his own government. Instead he expressed a willingness to meet representatives of the other governments at the border to discuss Mexico's "external" affairs. In the meantime his forces seem to be getting the upper hand, having regained possession of the City of Mexico and also taken Chihuahua which was Villa's capital. Villa has emulated the Russian by saving his army at the sacrifice of his cities. It is said that the American diplomats have invited Carranza to send delegates to meet them at New Orleans for conference separate from that with representatives of other revolutionary chiefs. There is a growing feeling that Carranza is likely to be recognized as the *de facto* ruler, presumably as a provisional measure preliminary to selection of a successor agreeable to as many as possible. General Obregon, the leading Carranza general, is mentioned in this connection and is said to be acceptable to Villa and his allies. Since the American governments seem hopelessly committed against intervention, this is perhaps as good a way as any to patch up a peace.

Russia.—The Kyshtim reports favourable results from bore-hole 18 at the Smirnoff mine which penetrated the northern end of the East vein 985 ft. vertical depth and the West vein at 1065 ft., which is 400 ft. deeper than the vein had previously been proved. The veins flatten somewhat as to dip. The East vein shows massive pyrite 3 ft. wide, followed by two zones of impregnation 12·1 and 2·8 ft. wide horizontally. The ore-shoot is at least 100 ft. longer to the north than on the third level. The West vein shows a foot-wall portion 41·1 ft. wide averaging Cu 2·8%, Au 0·10 oz. and Ag 0·98 oz. per long ton. Separated from it by 5·7 ft. is a hanging wall streak 15·2 ft. wide of lower grade ore. The significance of this bore-hole is that it shows workable bodies of ore nearly 400 ft. below the fourth or lowest level of the mine. Other bore-holes penetrating the vein below the mine but above 1065 ft., confirm these results.

Spain.—The Rio Tinto Co. has declared an interim dividend of £1 per £5 share for the first half of 1915. A year ago no interim dividend was paid, and the final dividend for the year 1914 was £1. 15s., as compared with £3. 15s. for 1913. The company has no electrolytic refinery, as the copper contains no precious metal. The directors do not tell us, but we may assume they are now sending copper to the United States for the production of electrolytic.

Various.—The Aluminium Corporation is making an issue of debentures for the purpose of expanding the scale of operations. This company has an electric smelting plant in Conway valley, North Wales, using water power obtained from the Eigiau and Cowlyd lakes.

The Wolfram Mining & Smelting Co., owning mines in northern Portugal, announces that a new contract has been secured for the sale of the output of wolfram concentrate until the end of 1916 at a greatly advanced price. This company used to sell to German buyers.

As recorded at the time, the Turks took possession of the mine and smelter of the Caucasus Copper Co. in November last. They were subsequently driven out in March, since which time the Russian troops have been in occupation. The Turks had removed the copper ingots, rubber and leather belting, tools of all kinds, and brass from the machinery. Otherwise little damage was done to the plant. The property is in the hands of caretakers.

EDITORIAL

FULL particulars regarding 'The Mining Register' will be found in our advertising pages, to which the discussion has been confined as being primarily a business matter.

CONSERVATION doctrines have taken hold in the Philippines, and visitors from the Islands to the Exposition at San Francisco report general dissatisfaction because of withdrawals of promising gold areas. This interest in the future is compared to that of Alice in Wonderland: "Jam every other day, that is, jam yesterday and jam tomorrow, but never jam today."

PRESENTATION by the Institution of Mining Engineers of its gold medal to Dr. J. S. Haldane, as told in our letter from Leeds, is another well deserved token of appreciation of the great work he has done for science and industry. Miners owe much to Dr. Haldane, a fact that we are glad to say is recognized in many lands, and it is pleasant to record that his accomplishments have now been recognized by both the official organizations that represent British mining. It is even more pleasant to record the fact that Dr. Haldane is well and active, with the promise for himself and the world of many more years of service and achievement.

WASHINGTON is to be the meeting place of the Second Pan-American Scientific Congress to be held from December 27 to January 8 next. The sections relating to Mining, Metallurgy, Economic Geology, and Applied Chemistry are being organized under the able direction of Mr. Hennen Jennings. He has recently announced two sub-committees as follows: Mining: Messrs. Van H. Manning, J. F. Callbreath, C. H. Lindley, E. W. Parker, H. C. Perkins, G. S. Rice, W. L. Saunders, and B. B. Thayer; Metallurgy: W. R. Ingalls, F. G. Cottrell, R. H. Richards, Bradley Stoughton, L. D. Ricketts, Karl Eilers, W. R. Walker, and G. H. Clevenger. With such men, and an appropriation by the American Government, a successful meeting and most excellent programme of rare technical interest can be safely predicted.

TIN and tin mining are attracting so much attention that we are glad to print the discussion of tin and wolfram in Cornwall presented at the recent meeting of the Royal Cornwall Polytechnic Society by Mr. J. H. Collins. As always, he writes with fulness of knowledge and wealth of detail.

MALAY tin mining has come to mean alluvial mining to such an extent that the importance of the lodes is in danger of being entirely overlooked. A year ago we presented an abstract of an interesting paper on the 'Tin Lodes of the Kinta Valley,' written by Mr. J. B. Scrivenor, Government Geologist to the Federated Malay States. We are now privileged to print an important contribution on lode mining in general in the Malay States, by Mr. W. R. Jones, sometime assistant to Mr. Scrivenor. This is to be followed by another and concluding portion.

GAS producers are, as Mr. W. R. Degenhardt remarks in the article we print on another page, but one form of furnace. At the same time they are, where they may be used, a highly efficient form and are rapidly finding new uses. Just two years ago Mr. W. J. Loring wrote for our readers on the economic phases of Mr. Degenhardt's work in adapting producers to gold milling in Western Australia. Keeping in mind the large element in costs that must always be charged to power production, the importance of the subject from this point of view is apparent. In a paper read at the Leeds meeting of the Institution of Mining Engineers, and mentioned in our Précis this month, Mr. M. H. Mills tells of the importance of gas producers in coal mining. They long since, in connection with regenerative furnaces, made a place for themselves in the steel industry, and are widely used in zinc smelting. Now, as Mr. Degenhardt notes, they are being applied in gold ore treatment, not only to furnish power but to facilitate roasting. The early attempts to use them in copper smelting were largely unsuccessful, though for special reasons they continued in use at Great Falls, Montana, until recently. Mr. Walter G. Perkins has applied them in reverberatory smelting at the Kyshtim, with most interesting financial and technical results, which we hope soon to give to our readers. Other applications are daily being made or suggested, and no mining engineer can afford not to keep in touch with progress along these lines.

THAT this truly is "an engineer's war" is becoming steadily more apparent. We print on another page the account of a few only of the distinguished services rendered by the mining engineers who have already gone into the trenches. Sometime we hope to be able to describe the actual mining which has been done along the trench lines this year, but it is not permissible now. We can only rejoice in the knowledge that our profession is distinguishing itself here as elsewhere, and join in sorrow at the death of those who fall. A recent bulletin of the Institution of Mining and Metallurgy lists 22 who have died, and of them 20 were students or associates, the younger men who were to have had part in the making of the tomorrow of the profession.

The Kyshtim Report.

The report of the Kyshtim Corporation, Limited, accompanied by that of its Russian subsidiary, the Kyshtim Mining Works Company, was distributed last week. The long delay has been due to the disorganization of industry incident to the war. The reports, now they are at hand, include a wealth of detail packed into few words that make their summation difficult. To consider the financial results first, it will be noted that the gross income for 1914 amounted to £1,059,523, of which £367,443 was net profit. This was slightly less than in 1913. As usual, the main source of profit was the copper production which amounted to 7588 long tons, and yielded a gross profit of £458,631. The iron works added to this £10,659, and the forests £23,557, to which minor items were added to bring the total gross to £502,130. Against this were charges of interest, taxes, and general expense, which brought this down to the net figure mentioned. Out of this it was proposed to pay a dividend amounting to £210,526, and to transfer £100,000 to depreciation. The remainder was to be reserved to meet special taxes in Russia or for general purposes. Owing to the abnormal condition of exchange it is not economical to bring money out of Russia at this time, and in view further of the opportunity for using capital to advantage in that Empire, we commend this determination to keep dividends moderate for the present. Technical matters are described in the report of Mr. R. Gilman Brown, the consulting engineer, according to which the total ore production for the year amounted to 364,524 tons, while the amount opened up in the same time was 558,000 tons. The total reserve now stands at 2,031,000 long tons "assured by development and bore-holes," and 636,000 "Extensions beyond limit of exploration." Of this reserve 366,623 tons assaying 2·66% copper was, on December 31, ready for stoping. The average of the ore produced in 1914 assayed a trifle higher, 2·87% copper. The gold amounted to 1·8 dwt., and the silver 1·1 oz. per long ton. Development may be said, without going into details, to have resulted favourably for the year, and the Kyshtim is evidently in a position to add to its ore reserves as rapidly as business conditions warrant. Mr. Gilman Brown notes that the deeper bore-holes show a uniform tendency to higher copper contents, and that the growing knowledge of the habit of the orebodies gives increasing certainty to estimates of the probable extensions of the orebodies. For the benefit of those who are not familiar with the Kyshtim we may recall the fact that the ore is treated by direct smelting, despite its low grade. In this it shows more kinship with the Balaklala in California than other American mines with ore of similar copper content where concentration of some sort is employed.

The treatment is by means of reverberatories and blast-furnace followed by the usual refining. There are many interesting technical peculiarities in the local practice which must await another time for description. Direct smelting is possible because of the high price of copper in Russia, the sale price for 1914 having been £92. 10s. 10d., and for 1913 £94. 2s. 7d. per long ton. For these years the cost of cathodes is given as £42. 1s. 10d. and £37. 7s. 1d. respectively. With such margin the company is well protected against even the devastating influence of war, with the labour shortage, disorganization of transport, increased cost of supplies, and revolutionary problems of exchange. These have all had to be met by the various Russian companies. The net result, as illustrated by the Kyshtim report, into which we have gone in this detail as illustrating the problem of the whole group, has been such as to emphasize the essential soundness of the business of the Anglo-Russian copper companies.

America and the War Loan.

In connection with the success of the war loan recently placed in America a great deal has been said as to the growing wealth of the United States and the high rate of interest charged for the money. There is a general impression in Europe that the United States is getting rich out of the war, and that its bankers have driven a hard bargain with the Allies. Neither impression is, we believe, entirely just. It is true that the credit balance in trans-Atlantic trade has swung heavily in favour of America. The average weekly balance in favour of the United States has been about £7,000,000, for nine months. The *Statist* estimates that if exchange difficulties be overcome the amount that the United States can invest abroad will be between £300,000,000 and £400,000,000 in the twelve months from the end of last July. Contrary to general belief the present large exports of the United States are not munitions of war. Instead they are, as they have been for years, mainly food stuffs and raw or partly manufactured materials. These bulk larger than usual because prices have gone up, and this is much more important quantitatively than the increase in shipments of manufactured goods of all kinds, including war material. The United States is rapidly increasing in wealth, but this is in spite of the war rather than because of it. In the years from 1904 to 1912, according to the United States census, the total wealth of the country increased by $80,000,000,000. This increase alone was equal to the total wealth of Germany as estimated by Dr. Karl Helfferich in 1913, and almost to that of the United Kingdom in 1914, estimated by Sir George Paish at $85,000,000,000. Excluding any marking up of real estate, the rate of increase from 1900 to 1904 was $2,186,000,000 per annum, and from 1904 to 1912, $4,600,000,000. All this, it may be noted, was before the war, and in the main even before the years in which, as we now know, definite and immediate preparation was being made for war. The reason for the rapid increase in wealth lies, of course, in the abundance of natural resources remaining unexploited. Another reason, of which there seems danger of losing sight just now, is that to the present the United States has had the use at a low rate of interest of enormous sums representing the savings of Europe. It is impossible to estimate the total exactly, but anyone concerned in Anglo-American business or trade knows how steadily and heavily Great Britain in particular has been drawn upon for money to build railroads, open mines, finance factories, and bring land under cultivation. The Pennsylvania, New York Central, Illinois Central, and other railways have obtained large sums in London and elsewhere at 3½%, and the money has been so invested as to bring its borrower a comfortably higher rate. It is well enough to talk glibly about America paying back the money owed abroad and changing from a debtor to a creditor nation, but in fact that means substituting 6% or 7% for 3½ or 4% money. From that point of view it is not a profitable business for Americans. The United States is still hungry for capital. It absorbs more than $100,000,000 of the world's gold production annually. Quoting again from the *Statist*, it is to be noted that the United States has been reinvesting annually in home industries £1,400,000,000, about one-fifth of its income. Somewhat more than two years ago it began to be especially difficult to get money in America. Despite excellent crops and good mine outputs, with all the fundamental conditions of prosperity favourable, the industrial machine slowed down. Standard securities remained low and money was mysteriously absorbed as fast as it appeared. It is now apparent that the Germans, and perhaps other far-seeing ones, were unloading American holdings and preparing for the storm that has since broken. The whole business world became uneasy, and the flow of capital into new projects nearly ceased. That hurt America, and is hurting her to-day, more than any profit possible from the war. The influence still continues. The *Economist* as recently as October 2 listed 47 American railways, the receipts of which for the latest month fell, as against 27 that showed slight increases. The annual reports of the great American railway systems have made dismal reading. Such sound roads as the Norfolk & Western, and the Chicago and North-Western show marked decreases in gross receipts. Other great lines have gone into the hands of receivers. In some instances, witness the Rock Island, it was due to dishonest management, but this cannot be applied in the case of the Missouri, Kansas, and Texas which failed to meet interest charges, at 6%, on short term notes, that it might have met if bonds at ordinary rates had been placed. For several years, moreover, the high-rate short-time note has of necessity been issued by American railways even where there was no question whatever as to the fundamental security. There simply is not enough capital in the United States to do the work required, and much of the money that is there is being hoarded in the banks, because of the uncertainties incident to the war. To the extent that the United States sends money abroad, either to buy American securities or in the form of loans, it robs home industries. This explains why Americans ask high interest rates on foreign loans. The competition is with local industries hungry for capital and against the disinclination to invest at all owing to the war's uncertainties. There is further the circumstance that Americans are not used to foreign loans. When they do not feel safe in lending where they see the security and know the business, it is not surprising that they ask interest at least equal to that obtained locally, when offered an unfamiliar security. The *Economist*, after wobbling a bit, concludes that the rate to be paid by the British and French Governments is about 6%. But, as it is careful to state further, this is offset by savings due to steadying the exchange rate, and it is to be remembered that the loan was really to solve problems in exchange—not to obtain money. The Americans have in fact extended credit to the amount of about one-third of the year's purchases by France and Great Britain. In hard times we all suffer, and in international relations as in the corner grocery, the wise merchant "carries his customer" to the extent of his ability, even though he must postpone for the season building the addition to his shop that would greatly facilitate business. That is what the United States is doing.

The Institution By-laws.

Incident to the receipt of the Royal Charter, it was necessary for the Institution of Mining and Metallurgy to present within six months a revised constitution and set of by-laws. The Council has had the matter under careful consideration and has distributed to the members, for action at the meeting of October 21, a draft of the proposed changes. From time to time the present organization of the Institution has provoked criticism. Many members have come to us with suggestions, some of them practical, and some of doubtful value. The Council now gives all such members an opportunity to present their suggestions. If the dissatisfied members are true to their convictions, they should attend the meeting and present their case. As early as 1911, and at subsequent dates, we have commented on the unwieldy character of the Council and the extremely limited rotation of its membership. Mr. S. Herbert Cox replied to our original criticism in an excellent letter in which he put the best possible face on the situation as it then stood. Despite the weight of his arguments, we have seen no reason to change our opinion that the power for good of the Institution would be greatly increased if it had a smaller and less cumbersome Council. We suggested at the time a membership of twelve, each serving three years; members so retiring to be eligible for re-election after some short but fixed period. We can assure our friends in the Institution that this plan works excellently, where, as in many places, it is in operation. As to the present plan of organization of the Institution, we can only say that it has worked better than any of us had the right to expect, but that it contains elements of weakness that limit the usefulness of the Institution. We have been interested to see that in re-writing the proposed by-laws, the committee seems to have recognized that in principle our criticism has been sound, but to have failed to provide for any very effective changes in practice. Our remarks seemed to have produced conviction without conversion. In the main, the changes are minor and the rephrasing is directed merely toward clarifying the meaning. The requirements for admission, for example, are restated in, we believe it will be conceded, simpler and more direct form, but without material change. There are, however, paragraphs into which new meaning as well as new phrasing has been put. The Council is hereafter to have power to suspend as well as expel from membership, a proper and possibly useful change. The long list of "Corresponding Members of the Council," a feature which we have criticized, is to disappear. In lieu there are to be "Corresponding Representatives," chosen from among members resident abroad, to whom matters may be submitted for advice and investigation. This is a wise change. An organization, which, while legally resident in London, has come to be in fact international in membership, should have definite means for keeping the Council in close touch with the various countries and dominions in which there is a large membership. The new plan will accomplish this and still avoid the difficulties of the old arrangement. Formerly, a non-resident member of the Council was often looked to locally for an amount of authority which he neither had nor should have. It was a case of responsibility without authority, which is always bad. At the same time, with so many such corresponding members, and having in view the migratory habits of mining men, it was always possible that the number present in London and eligible to vote in the Council might at any time complicate the situation for an already more than sufficiently cumbersome organization. In the vital matter of the unwieldy character of the resident council, the sole concession made is that hereafter only ten of the Past-Presidents, instead of the whole body, are to be *ex-officio* members. The Council is still to consist of "not less than twenty-six nor more than thirty-six members, inclusive of the President, Vice-President, and Treasurer," to which, as has been noted, are to be added the ten gentlemen who have most recently passed the Chair. In other words, the Council is hereafter to consist of thirty-six to forty-six members. For this small favour we shall try to be thankful, though the logic of recognizing the need of a limitation and still not making an effective one does not appeal to us. It is not a question of the character or calibre of the men who are brought to the Council by the present system. One needs but to read the list to recognize that service in that body is an honour that the biggest men of the profession accept with pleasure. The objection is more fundamental and lies against all large bodies in positions where constructive work is needed. The Council is admirably adapted for endless debate. It can, and does, work effectively when it comes to negation, but we are convinced that a large body cannot act promptly and efficiently on constructive matters because the differences of opinion paralyse the executive. Indeed one would be warranted in saying that the Council at times dodges responsibility, if no more dignified phraseology could be found. On mature reflection we are disposed to believe that it is wise so to recognize its limitations, but in the meantime who is to grasp leadership if not the body chosen to represent the profession? Lest our good friends of the house next door think we are over severe, we make haste to say that this criticism of large bodies where executive action is necessary is neither ours alone, nor directed only at the Institution. Mr. J. L. Garvin, the forceful writer of the *Observer*, recently referred to the British Cabinet of twenty-two members as a "miniature mob with a majority of members to whom public opinion attributes no real responsibility at all." We cannot improve upon that as a characterization of any large body of councillors of an organization, many of whom come to their position if not *ex-officio*, at least *pro forma*. The Council of the Institution does good work, but a smaller body such as we have suggested would, we believe, do still better. Perhaps there are other changes which should be made. It will be open to any member of the Institution to state his views at the general meeting, and an open discussion is greatly to be preferred to a continuation of individual criticism outside the Institution chamber. In view of the legal requirement for prompt presentation of the by-laws, no obstruction should be placed in the way of their adoption, but if the discussion shows any real need of change there are adequate methods of obtaining action later.

Excess Profits Tax and Gold Mines.

War is a costly business, and that new and heavy taxes must be levied and met is a matter of general agreement. Indeed, the Cabinet had the unique experience of facing a people who were literally demanding that they should be taxed heavier. There is no disagreement as to the necessity for new taxes nor much disposition to question the direction which the taxation must take. As we write, the actual framing of the Budget is in progress, and representations are being made, hearings are being granted, and various steps are being taken to secure the best system under existing conditions. It must be recognized that now, even more than in normal times, the manner of taxing adopted must be a compromise. It is no period for sticking out for the theoretically perfect system or for too prolonged or minute criticism of minor imperfections. All that can be done, and that may properly be done, is to see if possible that no grave injustice be done to any industry and no tax money raised on terms that destroy the industry taxed. We fear that there is just such danger as regards the incidence of the proposed war profits tax on mining, and particularly on gold mining. The general purpose, to make those who profit by the war shoulder as much as may be of its cost, is not only sound economics but good sociology. To the extent that mining companies have made unusual profits because of the war they should, without question, be taxed in the same proportion as are other corporations. It has, however, been proposed—we hope the plan may be changed—to make the measure of the excess the difference between the profits of the current year and the average for the three years preceding. One half this excess is to be taken as a war profit. The injustice of this plan is at once apparent, since the larger profits of the present year may be wholly the result of fruition of a long preceding campaign of development, and may well have nothing whatever to do with the war. To make the matter entirely clear, consider gold production. Gold has not gone to a premium and the mining companies get no more for it than before the war. On the other hand the cost of production has increased for a number of reasons incident to the war. Because of the vital importance of gold in international exchange the mines have been making every effort to increase production. There are many companies that have brought in, or are about to bring into commission additional plant. Are they to be penalized to the extent of 50 per cent of their profit for so doing? In response to the direct question put on September 29, the Chancellor of the Exchequer is quoted as saying yes; that it was not a matter of war profits but "the raising of additional revenue from the sources best able to contribute." Apparently the ground was to be taken that any company having additional revenue this year, whatever its source, was better able to stand taxation and so was an appropriate subject for excess profits taxation. We do not believe this is altogether fair or that it will work out to the benefit of the Empire. Gold in the ground is from one point of view not greatly different from gold hoarded in a chest or even that deposited in a savings account, except that it takes more time and effort to draw it out and set it at work. It will hardly be contended that a man who had drawn heavily on his savings account this year, perhaps to buy war loan, should forfeit as "excess profit" a sum equal to half that he had so drawn. Nor, do we believe, would it be seriously proposed to take as excess profit half of any sum of hoarded gold that one might, in response to present calls, bring out and put either into war bonds or into circulation. How is it different if a company, following long lean years of development and heavy expenditure for plant, takes gold out of the ground to meet the vital needs of the Empire at war? Nechi Nines was but organized in 1914 to acquire placer ground in Colombia and to build and operate gold dredges. Production has just begun. The company had no profit in any of the last three years and hence any now made is "excess," and forfeitable as to one-half, under the terms of the Act as proposed. We do not know what the directors propose to do, but they could hardly be blamed if the work were discontinued or the output reduced until more propitious times. Carrying the interest charge would be cheaper than paying half the profits to the Government in addition to all other local and Imperial taxes. In this connection it is to be remembered that the Rand mines are already contributing heavily to the war in the form of regular and special taxes to the Union of South Africa. This is a very real situation, one faced by a large number of companies, and on how it is determined may rest the question whether in the future as in the past the great gold mines of the world continue to be owned and managed by the British. From the company point of view there are several ways to meet the situation if it arise in fact. We do not want to counsel the unpatriotic, but we may properly mention plans that have been proposed and are under consideration in the City. One is, as we have intimated, to cease production or to reduce it to the point where the profit is just that of the average for the past three years. This would be especially hard on new companies only now coming into production, but after all, it is argued, ore in the ground does not disappear and the uncertainties of the future cannot be much worse than such a certainty of the present as just outlined. Companies that are in debt or have retireable debentures can limit dividends and clear their way for the future. Those which are merely holding corporations controlling local companies in Russia, America, or other countries, can limit the distributions of their subsidiaries and allow profits to accumulate either for re-investment abroad, or until the money can be brought home on more favourable terms. It would even be possible to dissolve a British holding company and distribute the shares in the subsidiaries, or to organize a new foreign company and sell British mines to it. In either case the initial distribution, being of capital and not a profit, would not be taxable. Subsequent profits would reach this country in the form of individual cheques to shareholders, and so be taxable only under the general income-tax law, as to which there is no complaint. The great drawback to this plan of transferring the property to foreign companies is that management and control would go with it, even though ownership continued in the hands of individuals residing in the United Kingdom. It would not be pleasant, nor might it always be good for the Empire, to see Rand mines managed from New York or Rotterdam; and in the long run it would not be good for mining to be cut off from direct access to the great London market. It is an old cry that taxation drives away industry, and we would not press the point, but certainly the Budget, as first proposed, portends a real danger in this instance. The matter is, fortunately, being made the subject of serious consideration. Mr. Stanley Elmore called prompt attention to it in the *Financial Times* which commented appropriately upon the particular hardship which the proposals bear upon gold mining. The Institution of Mining and Metallurgy, acting most fittingly for the industry as a whole, promptly took steps and saw that the difficulties of the situation were set clearly before the Chancellor. It is hoped that some reasonable modification of the original proposals may be secured. The fundamental difficulty in this, as in many other matters that relate to taxing mines, is that it is not sufficiently understood that dividends in mining by no means represent profits even with the safeguards of the British law. A mine, it cannot be too often said, is a wasting asset. Too often dividends from mining companies represent merely return of capital. When a mining company is wound up it seldom happens that the amount divided equals the capital, because plant is worthless without ore, and the latter, the chief possession of a mining company, is necessarily wasted in the operation. A big dividend from a mining company may not mean a profit, but merely a return of a considerable part of the capital. This difficulty is intensified when the British is merely a holding company for one organized in a foreign country, where laws governing payment of dividends, depreciation, and other vital matters may be entirely different. These matters are well understood by mining men but not sufficiently, we fear, by those who devise schemes of taxation.

Weights and Measures.

It is well to revert occasionally to a consideration of the present heterogeneous collection of antiquities that passes for a system of weights and measures in the English-speaking countries, and to inquire into the possibility of introducing reforms or standardizations. This subject may be approached in various ways. For instance, we may either discuss the total abolition of present units and the adoption of the metric system, thus following the lead of the Latin and Teutonic races, or whether it is more expedient to retain the present system and confine our activities to introducing minor reforms and securing a standardization of usage. Then again, the subject may be discussed according as it affects the convenience of the individual, the convenience of a particular trade or profession, or from the wider point of view of the requirements of the body politic. Let us take first the general question of the convenience and adaptability of the metric or decimal system. Many people object to the adoption of a system of units each ten times greater in the ascending scale or one-tenth in the descending scale, holding that 10 has only two aliquot parts, '2' and '5,' so that there is no provision for sub-units such as one-third, a quarter, or one-sixth. They urge that the recurring decimal introduced by the '3' is a factor inimical to precision, and that a continuous division by '2' soon introduces a long string of decimal figures. It has always seemed remarkable to us that the average man does not recognize the fact that both the ancient and modern systems of arithmetical enumeration are decimal systems as far as the numbers above unity are concerned, and that the application to amounts less than unity is not only logical but highly convenient. The decimal system was originated when the symbols '1' and '0' when placed together were made to signify 'ten.' The inventor of the decimal point rendered an immeasurable service to the advancement of exact science, for it is clear that irregular amounts less than unity cannot be gauged by adding together sub-units of the type of $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{64}$, etc. Such a proceeding would be too much like that of the Irishman who was given a 2 ft. rule wherewith to measure the width of a window; he came back with the rule, a piece of string, a brick, and a chip of wood whittled to fit. As we are used to having units in multiples of ten, why should there be inconvenience with similar units for subdivisions? The necessity for a sub-unit one-third of another is not obvious. The relationship of the foot to the yard is on this basis, but we could manage perfectly well with either only one or the other. The silver fourpenny piece, representing one-third of a shilling, was not wanted by anybody, and it was abolished. No doubt the duodecimal system would be theoretically more ideal, and if the human race had been made with five fingers and a thumb on each hand, this system would, of course, have been adopted. Other symbols in the arabic notation would have been required for 'ten' and 'eleven,' and the symbol '10' would have represented 'twelve.' But we cannot go back to the Creation for arithmetical reforms. The only serious competitor of the decimal system is that based on the continuous division by 2. For instance, we find this system firmly rooted in the machine-shops and on the Stock Exchange. In the last-named centre of activity, it holds sway against both the decimal and duodecimal systems, for quotations are not given either in shillings or pence. Fractions of a pound are given as $\frac{1}{2}$, $\frac{5}{8}$, $\frac{13}{16}$, or $\frac{21}{32}$, and fractions of a shilling at $1\frac{1}{2}$d., 3d., $4\frac{1}{2}$d., or $7\frac{1}{2}$d. Why these cramping measurements should be used in these two businesses is not clear, especially so with the Stock Exchange, where pounds and shillings so obviously afford a greater scope of variation. Before passing from this phase of the subject, we may remark that the desire to keep sub-units in symmetrical array has a real aesthetic basis, and 'thirds,' 'sevenths,' 'twelfths,' and 'sixty-fourths' are for that reason attractive, and are more concise than the fraction given approximately to three or four places of decimals. But nature does not always help in this exactitude of sub-units, the best example being the sub-divisions of time, where the day, month, and year are not related in any simple ratio.

So much then for the general question of the metric or decimal system. We may now proceed to the particular, and ask what inconvenience would arise to the mining and metallurgical professions from the adoption of the metric system of weights and measures. The depth of a shaft or winze, the height of a rise, and the length of a drift could be measured as easily in metres as in feet or fathoms. Short or long tons of ore and long tons of concentrate would be merged in the metric ton, and much confusion avoided. Grammes would be as conveniently used as pennyweights in measuring gold content per ton, and grammes or kilogrammes for silver content, while kilogrammes would serve the purpose for reporting total output. Kilogrammes of cyanide and lime would do just as well as pounds. Gallons of water would be as well expressed in tons, cubic metres, or litres, compressed air in cubic metres, and timber in cubic metres instead of cords. In the chemical laboratory the centimetre and gramme are already in universal use. In the mining community the kilogramme can be employed for measuring articles of food, and the litre for the, shall we say, tea, while the kilometre will do admirably for the films at the cinema show.

If the adoption of the metric system is considered too revolutionary for the English speaking nations, or if the present is not suitable for conducting the agitation in its favour, mining men can at any rate set their house in order by simplifying as far as possible the present system and by agreeing on a common usage. Serious difficulties, however, arise in organizing the standards within the profession, for we as a body cannot alter the legal status of the various weights and measures, and our standards must necessarily come into conflict with the official methods and records. The first unit requiring reform or definition, namely, the ton, exemplifies this difficulty. The long ton is the legal measure in Great Britain and the Overseas Dominions, and the official records are in terms of the long ton. Not long ago we printed a contribution from one of the Australasian Inspectors of Mines, in which he inveighed in no measured terms against the introduction of the short ton into the mine records and demonstrated the resulting confusion. In the United States the short ton is the legal measure, and as it is the older and more logical unit, it commands respect. It has been adopted at most mines controlled by English or American companies for their reports on ore mined or developed, and in spite of the confusion indicated and other disadvantages, we believe the best interests of the mining engineer will be served by its general adoption for this purpose. Official mining regulations are not, however, the only difficulties to be encountered, for the Metal Exchange and the buyers of concentrate and the sellers of metal in this country have also to be considered. Concentrate and metal are bought and sold in the United Kingdom on the basis of the long ton, and apparently no combination of mining men is strong enough to force an alteration in the custom. Thus we have the absurdity of a Transvaal tin mine reporting ore raised in short tons and concentrate produced in long tons. The discrepancies between various tons is not, however, confined to legal and business circles, for among mining men a large margin of difference is also often caused by the neglect to allow for moisture in the ore delivered to the mill. Ore in place is assayed dry, but in a wet mine, or in one where holes and broken ore are liberally watered, the broken ore is weighed wet, and unless due allowance is made for moisture, the mine tons and the tons delivered to the breakers or stamps will not agree. The amount of moisture varies widely from nothing at all in a dry mine, where no dust settling is practiced, to 10 per cent where the ore is soft and friable and the mine is wet. Thus the returns of content and yield per ton may contain discrepancies as great as those caused by the failure to specify the ton used. It is desirable that all mine reports should take moisture into consideration as well as indicate the long, short, or metric ton. Some of the English companies introduce complications by giving returns in different parts of their reports on varying bases. The directors may employ wet short tons in their report, but the consulting engineers in their analytical tables may recalculate the figures to dry metric tons, and the two statements when put side by side require some explanation. If, as sometimes happens, the two statements do not cover the same items, and one supplies what the other lacks, the inconvenience to the reader is considerable. After the ton, comes the gallon. Here again the American practice is of older date than that at present current in England, for the United States gallon of 231 cubic inches is the old English wine gallon as fixed in the seventeenth century, while the Imperial gallon dates from the days of George IV. The reformed English gallon affords an example of the endeavour made in this country to correlate the units of weight and capacity, for it was fixed so that a gallon of water should weigh 10 lb., and so be based on the identity of the fluid ounce of water and the ounce by weight. In the reports on the production of petroleum, much confusion is caused by the difference between the English and American gallons, and as there is no present hope of unifying international usage, it is necessary that all reports should carefully specify the unit. It is interesting to note that the old wine gallon survives in this country in connection with the brine wells of Cheshire, and without knowledge of this fact errors easily creep into calculations relating to English salt production.

Slowly the units of weights and measures throughout the British Empire and its dependencies are being regularized, in most cases gradually, so that native susceptibilities shall not be too rudely shaken. For instance, in the Malay Peninsula the native kati and picul have been modified and standardized, so as to have a direct relation to English weights. But because the native customs are respected, English mining engineers do not need to use these weights when reporting on tin mines in Perak to English shareholders, and for the sake of uniformity, we hope that in future engineers will use pounds per yard for the average content and tons for the total output. In South Africa the so-called Cape foot is slightly longer than the Imperial foot and is a survival of the original Dutch occupancy of the Cape of Good Hope. As all other weights and measures in South Africa are identical with Imperial standards, we may expect the linear and areal units to be altered eventually. We would say a word also to some of our friends operating in Russia, advising their adoption of English weights and measures instead of sagenes, funts, and poods. It is true that English engineers should have some respect for the sagene, for it was regularized in 1833 to measure exactly 7 ft., but as the metric system was legalized in the Russian Empire in 1900, we may take it that the old standards will be abolished in time, so that there is no object in preserving the Russian measures in reports of English companies. In any case, English investors are not expected to be experts in Russian tables, and it would be more straightforward to employ the units that the intended readers are most likely to understand. Then again, much confusion is unnecessarily introduced into reports on South American properties by the use of local weights and measures. For instance in Bolivia there are three different quintals, and unless a definite statement accompanies a report, misleading deductions may be made. We would take this opportunity of reminding engineers that though many different systems of weights and measures are extant in Mexico and South America, only the metric system is recognized legally, so that it is highly necessary that all contracts should conform to the regulations. Not only so, but by so doing endless confusion will be avoided. Many more examples could be given with the object of illustrating our argument in favour of lucidity and simplicity, but space does not permit. We may suitably sum up our views by advising engineers to use the metric system wherever possible, and always to champion it; to use the simplest of English weights and measures, and in cases of uncertainty to specify the unit; to avoid, when addressing an English audience, the use of weights and measures not likely to be understood.

FIG. 1.—VIEW FROM GUNONG BAKAU TOWARD PAHANG.
In the valleys between the hill tops peeping through the clouds, alluvial tin-bearing deposits are worked in many places.

MINERALIZATION IN MALAYA. I.

By WILLIAM R. JONES.

A general impression prevails that tin occurs in the Malay States only in alluvium. This is an error and in fact tin occurs *in situ*, at or near, nearly all the mines. It is actually worked on a large scale at several points and in the future lode mining will become increasingly important. The failure to recognize the occurrence of the tin *in situ* resulted in part from the mistaken belief in the glacial origin of the deposits. Reasons against this theory are given and typical deposits are described.

IT has been my privilege, since my return from the Federated Malay States about four months ago, to meet some very eminent mining authorities and these, it was found, expressed surprise when told that tin-ore occurred *in situ* in that country. Their surprise increased greatly when mention was made of lodes which had proved exceptionally rich in tin-ore, and it was pointed out to me that very little, if any, available literature existed dealing with lode mining in Malaya. It was this latter fact, together with the great economic importance of the subject, that induced the Editor of *The Mining Magazine* to invite me to write an article on lode mining in the Malay Peninsula. I readily consented, for the subject is one that specially appeals to me not only because of its great scientific interest but also because of its importance to a country whose future will depend, from a mining point of view, almost entirely on the tin ore to be found there *in situ*. The present title of the article has been adopted instead of that of 'lode mining' because, in addition to the descriptions of well marked lodes, attention will be drawn to important bodies of ore occurring *in situ* in granite and associated rocks which, although of economic importance, cannot be correctly described as 'lodes.'

One reason why so little is known of lode mining in Malaya is that in former years by far the greater part of the tin ore was obtained from alluvial deposits and no big European-owned mines, with the exception of the Pahang Consolidated Mines, worked ore which occurred obviously *in situ*. No difficulty is experienced as a rule in a temperate climate in deciding between ore that is not *in situ* from ore that is *in situ*, for in the former case the deposit can generally be easily removed and treated, whereas in the latter case blasting and crushing is necessary. In a moist tropical climate where granites and schists have been decomposed *in situ* in some places for over a hundred feet below the surface, and where the decomposed rock can be easily removed by water made to flow rapidly over it, care is required to decide, in some cases, whether the ore worked is or is not *in situ*. An interesting and illustrative case occurred at a certain mine in Malaya where the manager applied for a rebate on the tin duty, given at that time by the Government to mines engaged in 'lode mining.' The deposit worked was friable ground which was removed by hydraulicking, but the geologist, whose opinion was sought, proved conclusively that the ore occurred definitely *in situ* and the rebate was granted. The object of the Government was, however, to encourage the introduction of crushing machinery, and a necessary change was later made in the mining regulations to attain that object. The difficulty is increased by the fact that, in places, the weathered rock resembles alluvium, but it will generally be found that veins of quartz, quartz-tourmaline, or small veins of kaolin still keep their direction through the decomposed ground, and where the undecomposed rock has been reached in the working face, these will be found continuous from the unweathered into and through the weathered rocks.

The other important reason why the belief exists that tin-ore has not been found *in situ* to any extent in the Federated Malay States is that the Government Geologist, Mr. J. B. Scrivenor, has propounded a theory that the tin ore bearing deposits of the famous Kinta district, were, for the most part, of glacial origin and had been transported by ice agency from an old tinfield situated somewhere to the west of the present position of the Peninsula. This theory created great interest in geological and mining circles and it was, to some extent, accepted as the correct interpretation of the geology of that area. It was not the intention of the author of that theory to create a sensation but simply to offer what appeared to him to be the best explanation of the facts as seen in the field. The fact remains, however, that at the time when lode mining was coming into prominence in Malaya, the glacial theory of the origin of the tin ore deposits of Kinta district was published, and reviews of it appeared in the leading mining papers. In spite of the fact that Mr. Scrivenor had himself drawn attention to certain parts of the Kinta district where the ore was found *in situ*, yet in the glare of the glacial theory the belief was established that very little, if any, tin ore was found actually *in situ* in Malaya. One of the objects of this article is to remove that misconception and to draw attention to a number of lodes that have been worked for tin ore in various parts of Malaya. Mineralized areas which have only been partly prospected and those in which I, in the course of geological survey work, proved for the first time the presence of cassiterite *in situ* will also be treated but with necessary reserve.

Before, however, entering into descriptions of individual lodes it will add to the importance of the subject if a few words are first stated about the supposed glacial origin of some of the tin ore deposits. It is not proposed to give in this article in detail the numerous reasons which militate against Mr. Scrivenor's theory; that has been done in a paper on 'The Origin of the Tin-ore Deposits of Kinta District,' read before the Geological Society of London on June 23, 1915. A very brief summary of some of the reasons will, however, enable the reader to realize that even in the Kinta district the original sources of all the tin ore obtained from that area have now been located in that district, and that the question of the origin of the deposits has been placed beyond reasonable doubt. A simple interpretation, in place of a very complex one, has been given to the geology of the district, which not only clearly explains all the features which led to the adoption of the glacial theory but proves that the theory is impossible.

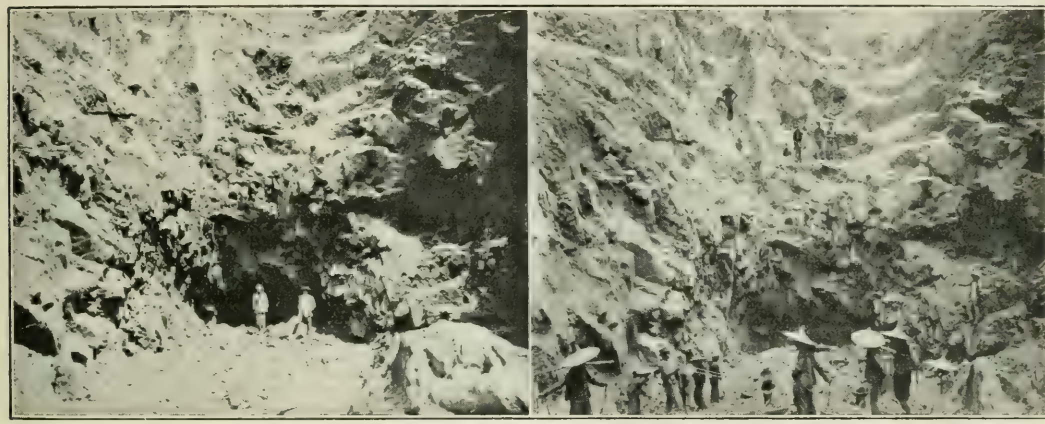
In my paper on 'The Origin of the Tin-ore Deposits of the Kinta District' I point out that more than half of the district is occupied by granite proved to be stanniferous in a large number of places both in the Main Range and in the Kledang Range, which form, respectively, the eastern and western boundaries of this area. The limestone cliffs forming a striking feature on the east and northeast of the Kinta valley are not essentially the result of faulting as described by Mr. Scrivenor, but of unequal denudation on a strongly jointed limestone, and hence the position on the valley floor of the deposits (with the exception of clays obviously formed by the weathering *in situ* of the schists and phyllites) makes it impossible to regard them as being contemporaneous with the Indian glacial clays of Talchir age, or indeed as anything but alluvial deposits derived from the weathering down of the neighbouring rocks. The author of the glacial theory found it necessary, in order to explain certain features, to hypothecate a whole chain of remarkable coincidences and of very unusual phenomena, such, for example, as the following:

1. Simultaneous faulting over an extensive area, with fault planes in various directions and with 'throws' of several hundred of feet.
2. Magmatic stoping, on an enormous scale, but over selected areas only.
3. The deposition of supposed Permo-Carboniferous glacial clays containing different types of rocks on different sides of the same valley, the dividing line between them being coincident with the present chief drainage course of a valley of post-Cretaceous age.
4. The superposition of two important tinfields, one of Permo-Carboniferous age and the other of Cretaceous age, in one and the same district: and, in the former case, in a very restricted part of that district.
5. The absence of metamorphism in clays lying between highly metamorphosed beds and in contact, in places, with enormous masses of granite.

Reasons for accepting instead the theory of origin *in situ* may be summarized as below:

1. Tin ore has now been definitely proved

in situ in this district, (1) in the stanniferous granite of the Main Range and Kledang Range, which flank the Kinta valley, and which in several places are being exploited for tin ore; (2) in other stanniferous granite outcrops, almost certainly connected with the granite ranges, and which have yielded, and are still yielding, tin ore; (3) in the schists and phyllites, toward the granite junctions, and which in numerous places are worked for the ore occurring in them as stockworks, and in the granitic veins intrusive in them; (4) in the large number of granitic intrusions traversing the limestone floor of the Kinta valley, and forming an important source of ore.



FIGS. 2 AND 3.—HEMY'S LODE, SUNGEI BAKAU MINE.
The rock was phenomenally rich where two lodes intersected at the point shown in Fig. 2. Chinese coolie workers are shown in Fig. 3.

2. The angularity of the boulders and tin ore in a clayey matrix is due in places (*a*) to the weathering of the phyllites and similar rocks into clay which sank gradually on the dissolving limestone underneath, resulting in the breaking up of the veins of quartz and pegmatite veins traversing the phyllites; (*b*) to soil creep effecting the same result; (*c*) to the breaking up of granitic intrusions after the surrounding limestone has been dissolved away; (*d*) to the breaking up of the much weathered tin-bearing pebbles in the alluvium.

3. With the exception of two mines, tin ore has now been found *in situ* either on the mine or on the property immediately adjoining it, in each of the 20 largest tin mines in the Kinta district.

4. Over 90% of the ore worked in the district is obtained from mines situated at less than a mile from granite or granitic intrusions; and over 80% of the ore is obtained from mines where granite or a granitic intrusion has actually been proved on the property.

5. No other tin-ore bearing deposits in Malaya, in the neighbouring islands, nor in that part of the world have ever, so far as is known, been described as of glacial origin, except those of the Kinta district.

DESCRIPTIONS OF LODES.

Tin-ore lodes have been worked in the Federated Malay States in granite, in schists and phyllites, and traversing the metamorphosed limestone near, or at the granitic junctions. A little ore has also been found in granitic intrusions in quartzite, but no case is known to me where tin ore occurring *in situ* in quartzite has been worked to a great extent. The reason for this is that the granite country is separated from the quartzite country, at least in a great part of the peninsula, by schists, phyllites, and metamorphosed limestone, so that the quartzite country is beyond the areas where mineralizing gases were very active during the later phase of the granite intrusion. It is proposed to deal, therefore, with (*a*) lodes traversing the granite; (*b*) lodes traversing schists and phyllites; and (*c*) lodes traversing metamorphosed limestone.

(*a*) LODES TRAVERSING THE GRANITE.

Some of the most interesting, and certainly the richest lodes so far found traversing the granite of Malaya, occur on the Main Range at Gunong Bakau,* at a height of well over 4000 ft., where the range forms the watershed between the state of Pahang and the district

*Gunong is the Malay word for mountain

of Ulu Selangor. Three important lode mines are situated near the crest of this mountain and within a short distance of one another. That of Mr. Bibby adjoins Tan Kim Bee's mine, the former being on the Pahang side and the latter on the Selangor side of the main watershed. The third mine, popularly known as Hemy's Lode (Sungei Bakau mine) is only a few chains from the other mines, and it is here that was discovered the greatest concentration of tin ore, occurring *in situ*, not only in the Malay Peninsula, but so far as can be ascertained, in any other part of the world.

HEMY'S LODE (SUNGEI BAKAU MINES).—The rock composing Hemy's Lode is not sufficiently coarse grained for a typical pegmatite, and although containing a higher proportion of acid minerals than ordinary granite, it is perhaps best described as an altered medium grained granite very rich in quartz, muscovite, and cassiterite, relatively poor in felspar, and containing a little fluorite. Microscopic examination shows that the greenish tint, so noticeable when the rock is wet, is due to the presence of chlorite formed by the alteration of biotite. Some of the mica appears to be secondary, and here, unlike the rock at the two neighbouring mines, topaz is absent. An interesting point in a granite so extremely heavily mineralized is the small amount of pyrite and mispickel on the one hand, and the abundance of tourmaline on the other. This is noticeable in other parts of Malaya, and although tourmaline, pyrite, and mispickel are known to occur together yet the abundance of the former seems to be at the expense of the other two, whereas the reverse is true in at least some places. A good illustration of this is furnished in the neighbouring mine (Bibby's). The rock in one part is particularly rich in pyrite and mispickel which occur in intimate association with the cassiterite, whereas in other parts little mispickel and pyrite are present but tourmaline is plentiful. So persistent is tourmaline in parts of Malaya that the Chinese call it by a name which means 'friend of tin.' The point will not be pursued further here except to point out the probability that in the places where pyrite and mispickel are particularly abundant and intimately associated with cassiterite, and when tourmaline and topaz are relatively scarce, the cassiterite may have been carried from below not as fluoride, as is generally the case, but as a sulphide, as an arsenide, and perhaps as a sulph-arsenide. Such an intimate connection between cassiterite and sulphides has also been noticed in certain localities in Cornwall,* and I hope to have the opportunity before long of writing a short paper on this interesting question. It remains to add that the ore obtained from Hemy's Lode is so free from sulphur and arsenic that it has been found unnecessary to roast the ore to obtain the top price for it.

The rock being crushed by footstamps at the time of my visit was phenomenally rich in tin, and the large specimens selected as representing the lode material gave, when crushed and washed, 23·9% by weight of tin oxide. Large patches, which were frequent, contained well over 50% of cassiterite and occasionally lumps as large as a man's fist of virtually pure cassiterite were obtained. This extraordinary enrichment occurred at the intersection of two main lodes and one subsidiary lode. These are shown on the photographs, Figs. 2 and 3. Lode A had a bearing of 11° S of E to 11° N of W; lode B a bearing of 35° E of N to 35° W of S; and lode C a bearing of 40° E of N to 40° W of S. Lode A showed evidence of thinning and of being deviated westward by a fault. Lode B was not quite so rich as lode A, but formed a stronger lode, and it was suggested to the manager that it would probably persist for a greater length than lode A. When the enrichment area was passed, namely the intersection of lodes A, B, and C, the percentage of ore, as was to be expected, dropped enormously, but there is reason to believe that when the precipitous faces of the mine, which is worked as an open quarry, have been rendered safe, or when the drifts from the mountain side have reached underneath the intersection of the lodes, careful prospecting will reveal further enrichment. The continuation of lode B and the deviation of lode A have now been proved.

The output of this mine, in spite of the fact that there was not a single piece of machinery, other than footstamps, on the small property, created a great sensation in Malaya, especially during the first eight months of the year 1913. Although fewer than 200 coolies were employed and the cost of transport of the ore was heavy, the two European owners and the European who worked the mine on 55% tribute made enormous profits. No secret was made of the fact that the profits sometimes reached over £3000 per month when working in the enrichment area.

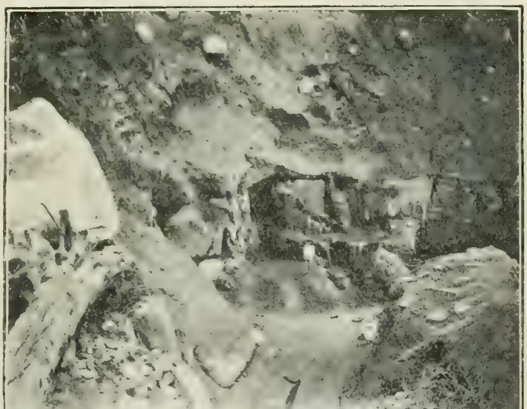
BIBBY'S LODE.—The tin ore occurs here in fresh undecomposed rock which varies considerably in type in different parts of the

* Thomas, H. H., and MacAlister, D. A. 'The Geology of Ore Deposits.' Pub. by Edw. Arnold, London, 1909. pp. 86 and 92.

property. All the types, however, belong to the granite family, and it would be difficult to find an area more full of interest in its petrology and mineralogy. The two chief types of rocks worked for ore are characterized by an abundance of topaz, and the origin of the topaz and cassiterite in these rocks has been a matter of disagreement between Mr. Scrivenor and myself. Mr. Scrivenor considers that the topaz and cassiterite in the two rocks, which he names 'quartz-topaz' and 'topaz-aplite,' are not alteration products of previously formed minerals, but crystallized from the molten rock as topaz and cassiterite, and he has written a very interesting paper on the subject.* Previously, however, he had described the quartz-topaz rock as valueless and stated that "if it be correct to assume that the Chinchong rock is an alteration product, it was due to there having been in this part of the granite magma a large quantity of free hydrofluoric acid capable of attacking felspar without the precipitation of a previously combined base such as tin."† Mr. Scrivenor was unaware of the fact that although in a few small patches the quartz-topaz rock did not contain tin ore yet the rock as a whole contained cassiterite and in some places was sufficiently rich in ore to permit it to be profitably exploited in spite of the heavy cost of transport. The danger of relying on microscope sections when dealing with the accessory minerals of a rock is well illustrated by this case, but it must be pointed out that Mr. Scrivenor was dealing with a few patches of rocks on the sides of a mountain covered with vegetation. The theory that the topaz had been formed by the action of fluoriferous vapours on felspar, and that the abundance of such a mineral in a stanniferous area was an indication of intense mineralization, enabled me to find cassiterite *in situ* in several places on Gunong Bakau and to find an important occurrence of tin ore at some distance from these lodes. A paper dealing with Mr. Scrivenor's present revolutionary theory of the origin of topaz and cassiterite of this neighbourhood is in course of preparation and it will be sufficient for the present purpose to state that the veins of topaz-bearing rocks appear to be intrusions, during the later phase of the main igneous intrusion, of the acid differentiation products of the granite magma; and that the topaz and cassiterite they contain are the

*Scrivenor, J. B., 'The topaz-bearing rocks of Gunong Bakau.' Q. J. G. S., Vol. lxx, 1914, pp. 363-381.

†Scrivenor, J. B. 'The Geology and Mining Industries of Ulu Pahang.' Kuala Lumpur 1911, p. 24.



FIGS 4, 5, 6.—BIBBY'S MINE, ULU CHINCHONG.

Fig. 4, at the top, shows one of the supposed horizontal lodes; the rock is a topazized granite. Fig. 5, on the left, shows a drift into the topazized granite; note the disturbed character of the lode near the fault on the left side. Fig. 6, on the right, shows the same lode on the right of the fault.

result of the action of tin fluoride on felspar, the tin fluoride first attacking water vapour to form tin oxide which was deposited, and the hydrofluoric acid evolved attacking the aluminium and silica of the felspar to form topaz.

No attempt will be made here to discuss the value of a property which may, at any time, be on the market. The rock in places gives between 1% and 2% of cassiterite; in other parts it carries under 1%, whereas in some of the working faces it forms over 6% of the rock. The hard undecomposed rock, when broken, is transported by aerial ropeway to the crushing plant at a lower level, and some distance away.

Some of the mining engineers who have examined this property seem to agree that the hill has one wide horizontal lode running through it and six smaller lodes, also parallel, which traverse part of the hill. The views they have gathered are worthy of serious consideration, but the following observations will, it is believed, show the impossibility of the occurrence here of such a very unusual phenomenon:

1. A main horizontal lode, with other smaller parallel lodes, traversing, over a considerable area, an igneous mass would be a remarkable occurrence anywhere; and in a district where faulting has occurred on a big scale it would be extraordinary, although not impossible; but in an area where the lodes themselves show distinct faulting in various directions it is impossible.

2. The bands of tin ore bearing rocks exposed on parts of the mountain side cannot be regarded as parallel lodes, for the intervening rock has not been prospected except in a few patches on the surface; and the actual outcrops of bands of rocks may appear as parallel outcrops on a mountain side, even though the planes between which the bands occur may be at various angles.

3. It has now been proved that the 'main lode' varies in direction to the extent of over 20%, on the two sides of a fault, in a distance of a few feet.

TAN KIM BEE'S MINE.—The rocks crushed here are, in places, the same as those which occur on Bibby's mine. The photograph (Fig. 7) shows clearly a fault, with a throw of about 14 ft., in the strong band of topazized granite carrying a fair quantity of ore. It is interesting to point out that patches of rock, indistinguishable from that mined at Hemy's lode, have recently been found here in association with the veins of topazized granite and, in one case, not more than a few feet from a greisen. The rock was very rich in cassiterite, but only a few tons of it were obtained.

It is worth noting that Gunong Bakau, situated almost in the centre of the Main Range, and several miles from the main granite junctions of this range, supplies a case where rich tin ore deposits occur well in the granite country and away from the periphery of the igneous mass; and although metamorphosed sedimentary rocks are known in parts of the Main Range, no such rocks occur within some miles of the summit of Gunong Bakau.

THE MENGLEMBU AND CHENDAI OREBODIES AND BUKIT KAMBING LODES.—One of the best known 'lode mines' in the Peninsula are the orebodies worked by the Menglembu Lode Syndicate, one reason being that the word 'lode' occurs in its name, and another that the mine is worked by a European company, and on a fairly big scale. In 1913 it had the ninth biggest output of the mines of the Kinta district, and accounted for 4276 piculs, or over 281 tons of tin ore.

The mines named above overlook part of the western side of the Kinta valley, and are situated on the flank of the Kledang Range, well within the granite country. Several orebodies have been discovered in this part of the Kledang Range, and although one or two of these can be definitely described as 'lodes,' for instance, that on Bukit Kambing, the orebodies in most cases occur in the forms of pipes or shoots, having little lateral extension but known to persist in some cases to a considerable depth, in one case to a depth of about 500 ft. In the Menglembu Syndicate's mines, where considerable development has taken place, the orebodies have been found to be very irregular in form, sometimes being confined to narrow pipes which elsewhere abruptly opened out, resulting in a form much like that of a number of bottles placed on top of one another, neck to neck, and base to base, and sometimes of the form resembling that of a round, turned leg of a table or chair.

Orebodies have been proved on the Syndicate's property in about eight places in a distance of 1000 yards, and two of these have been found to join together at depth. At Chendai some orebodies have been found which occur *en échelon*, but when I last visited the property not sufficient evidence was available to decide definitely, in an area covered in part with vegetation, whether this was due to parallel faulting subsequent to mineralisation, or to the disposition of orebodies in fractures formed before the area was mineralised. It

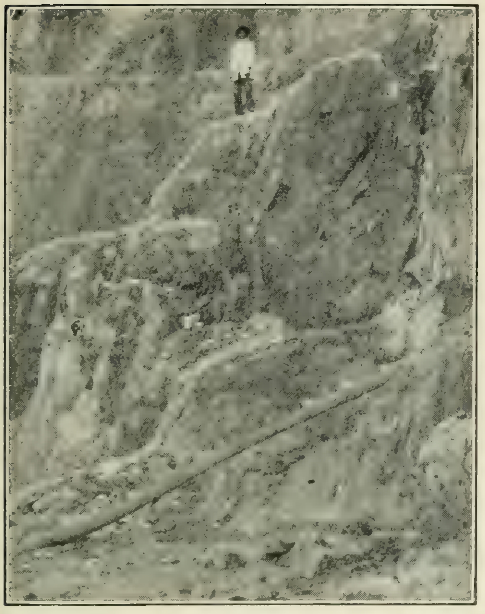


FIG. 7.—A FAULT IN THE TIN-BEARING TOPAZIZED GRANITE, TAN KIM BEE'S MINE, GUNONG BAKAU.

is certain, however, that the granite of this neighbourhood had been much fractured before the deposition of the tin ore, which occurs in the rock in these orebodies along minute fracture planes, parallel to one another, and keeping definite directions. A specimen in my possession (Fig. 8) has no fewer than 21 fracture planes in one inch of the rock. Microscopic examinations of the Chendai and Menglembu rocks show the presence of schorl, pyrite, and mispickel, in addition to the cassiterite, in the fracture planes, and show also that the fractures are so minute in places as to break the continuity of the ore and associated minerals, giving the appearance of a number of parallel elongated microscopic gash veins. (Fig. 9).

In addition to the form of the orebodies and the mode of the occurrence of the ore in this neighbourhood there is one other point of great mineralogical interest, namely, the freshness of the felspar crystals in this tin-bearing porphyritic granite. Attention was first called to this point by the Government Geologist,* and its significance, in relation to the theory of kaolinization by the agency of hydrofluoric acid, has been described by the present writer in his memoir on 'Clays of Economic Importance.'†

*Scrivenor, J. B. 'The Geology and Mining Industry of Kinta District.' Kuala Lumpur, 1913, p. 62.

†Jones, W. R. 'Clays of Economic Importance in the Federated Malay States.' Kuala Lumpur, 1915, pp. 13-19.

OTHER LODES AND MINERALIZED AREAS IN GRANITE.—It is not intended to give a description of all the lodes traversing the granite, for they are very numerous, and those already described represent at once the most important from an economic standpoint, and the most interesting in their mineralogy that have so far been worked in the Federated Malay States. Veins of aplite and pegmatite, frequently carrying cassiterite, are particularly common, traversing the granite of the Main Range in Ulu Selangor and Kinta districts, and are being worked on numerous small Chinese-owned mines. The veins are so rich in quartz in places that it is more descriptive to refer to them as quartz-veins, and the evidence seems to be clear that the majority represent, as do the aplite and pegmatite veins, the residual acid magma intruded into the fissures formed during the later phase of the main igneous intrusion when the granite was consolidating. The origin of other quartz veins near the granite junction is discussed later under the heading of veins in schists and phyllites. It frequently happens that the quartz veins carry cassiterite in a very sporadic manner, bunches of well formed crystals sometimes occurring in patches separated by a few feet of barren milky quartz. The cassiterite generally, but not always, occurs more frequently along the

FIG. 8.—CHENDAI ROCK, CONTAINING TIN ORE IN MINUTE FRACTURE-PLANES IN PORPHYRITIC GRANITE.

FIG. 9.—MICROSCOPIC SECTION OF CHENDAI ROCK. Note the freshness of the felspars.

periphery of the quartz veins, but lumps of cassiterite in the middle of the vein, and completely surrounded with milky quartz, are not infrequent.

In mineral wealth the granite of Malaya is not, however, confined to lodes, to orebodies of the forms of pipes and shoots, nor to definite areas of intense mineralization, for cassiterite is also found to occur disseminated through the granite over extremely wide areas, and although this has contributed greatly to the richness and extent of the alluvial deposits in the river beds and valleys, such general mineralization adds to the difficulty of prospecting for areas of more intense mineralization. It has been said that it is impossible to wash any stream bed in Malaya without finding traces of cassiterite, and although this is not true in the case of the streams having their sources and courses in the quartzite country, and of some other streams, yet it seems to be true of every stream having its source in the granite of the Main Range. In the course of my geological work, most of which was confined to the field, I spent considerable time on the Main Range in Ulu Selangor and I did not find a single stream bed that was entirely barren of cassiterite. Indeed the ordnance survey maps will show that in most cases mining leases have been taken up in the beds and along the banks of these streams, but mining leases do not, by any means, represent the areas to which John Chinaman confines his activities in parts difficultly accessible and covered with virgin jungle. Incidentally, it may be stated here that I regard the Chinese tin stealers as excellent prospectors, and I have profited much from the use of their paths and temporarily abandoned huts. By following a stream, previously worked by Chinese tin stealers nearly to its source, I was able to find cassiterite *in situ* near the summit of Gunong Raja at a height of over 5000 ft., the highest point, it is believed, that cassiterite has so far been discovered *in situ* in the Malay Peninsula.

Korean mineral resources were discussed at a Mining Conference which was held at Seoul on September 25 and 26 under the auspices of the heads of the Mining Bureau of Chosen. Information was collected with regard to ore deposits, and the resources of the country are to be advertised abroad by suitable publications. We note also that a Korean Mining Institute is to be organized, under the initiative of Messrs. A. H. Collbran, E. W. Mills, and A. R. Weigall.

Vanadium Steel.

In the Journal of the Iron and Steel Institute, No. 1, 1915, Professor J. O. Arnold, of Sheffield University, puts on record some early experiments made by him with regard to the effect of the addition of vanadium to steel. His reason for taking this step is that a foreign firm made use of the information given by him in a way that was misleading. The facts are given herewith. In the spring of 1899, the late August F. Wiener approached Professor Arnold with a view to ascertaining if anything was definitely known as to the influence of vanadium on steel. Mr. Wiener was interested in a silver-lead mine in Spain, in which a vein has been discovered assaying high in vanadium. He was also managing director of a syndicate that had established a small works at Llanelly, South Wales, where metallic vanadium was to be produced. Professor Arnold informed him that so far as he was aware there were no definite data on the subject, but that if he, Mr. Wiener, could supply some pure 33% ferro-vanadium he would undertake researches, stipulating that the results if favourable should in the first instance be communicated only to Sheffield steel manufacturers. Professor Arnold made three reports. Unfortunately a copy of the first got into the hands of a foreign firm who used it for their own purposes. We extract the following paragraph from Professor Arnold's report:

"The mechanical results of the tests suggested that the steel when made into drills and hardened and tempered would exhibit extraordinary cutting power. A drill from bar No. 618 was tested against a special quality drill containing 1·2% of carbon and 3·0% of tungsten. It was found that the vanadium tool hardened well at a very low, in fact hardly visible, red heat. A drill was broken after hardening, and exhibited a superb fracture showing practically perfect homogeneity. The drills (3·0% tungsten and 0·3% vanadium) were tried dry on a slab of chilled white iron. The drills, which were of the same pattern, were each worked at their full cutting power for ten minutes and the resulting drillings were weighed. The vanadium drill had removed 3½ against 2 ounces removed by the tungsten steel. The results of this preliminary investigation have profoundly impressed upon my mind the future before vanadium as a steel-making element, and even at this early stage of my knowledge of its effects, I venture to say that its action resembles that of tungsten, but that it is from ten to twenty times as powerful as the latter element."

WOOD-GAS PLANTS FOR MINES

By W. R. DEGENHARDT.

In Western Australia a difficult fuel problem has been met and a large saving made through introduction of gas engines and producers running on wood. The producers are of the down-draught type which permits simple plant and economical burning. With no standby, a running time of 98% is realized. It is suggested that similar economies are possible where coal is used for fuel.

WHERE fuel is high priced and water power is unobtainable, gas power may frequently be adopted at mines to great advantage. The economical production of gas for the engine supply is of the greatest importance, and while the local fuel available is almost invariably used, this is not always done to the best advantage. In the early days of gas-engine power on the West Australian goldfields, the local hardwoods, mostly mulga and salmon gum, were first converted into charcoal by burning either in ordinary earth kilns or specially lined steel shells, and the charcoal used in the producers. The cost of such charcoal would vary from 45 to 65s. per ton delivered, according to the locality and the kind of wood used. The cost of the wood alone, delivered in the same way, would be from 9 to 15s. per ton, and its calorific value might be roughly taken as one half that of charcoal. For equal calorific values the cost of wood and charcoal would be therefore in shillings :

Wood per equivalent ton of charcoal.	Charcoal per ton.
18	45
to 30	to 65

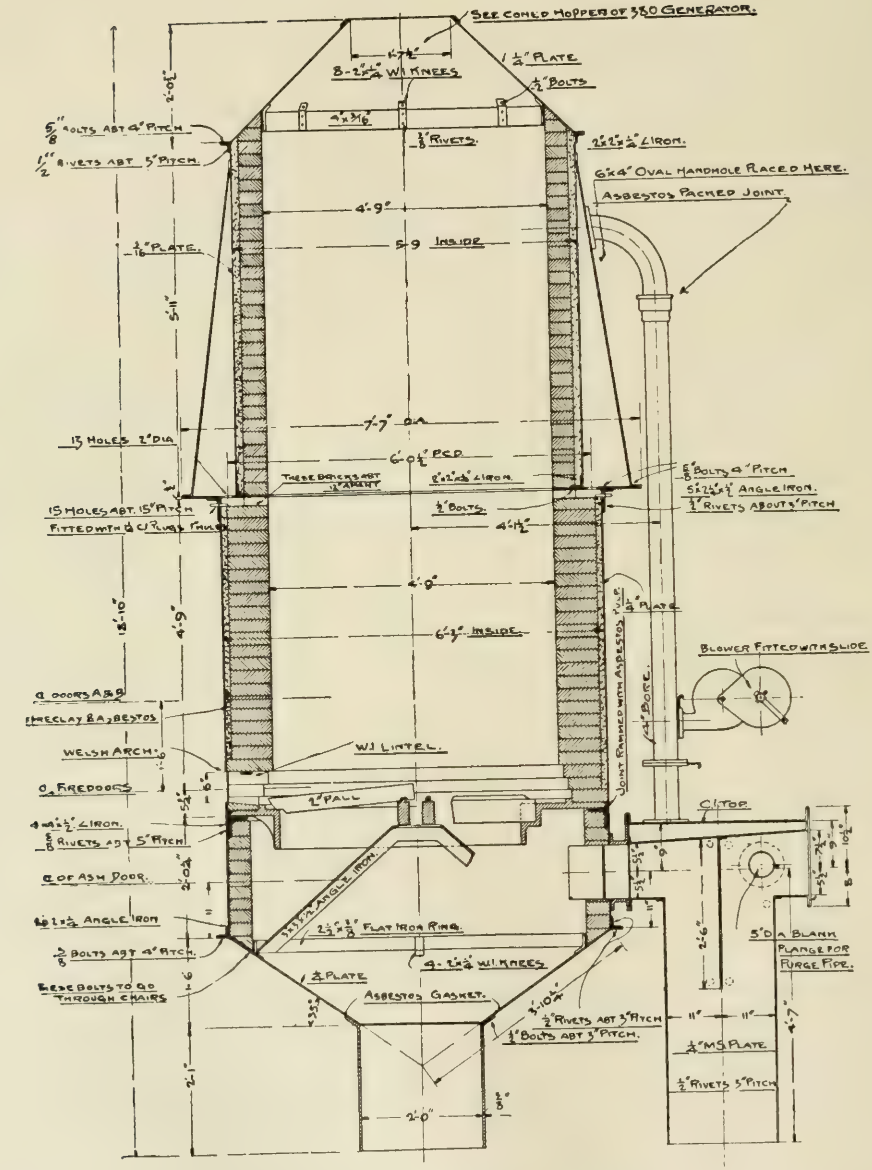
A saving is thus shown, if wood could be used without previous conversion into charcoal, of from 25 to 27s. per equivalent ton of charcoal. This fact was the cause of the introduction in West Australia of gas producers, using wood direct as fuel.

Having been intimately associated with various mines with surface plants driven by gas-power derived from charcoal used in producers, I had, as chief mechanical engineer to a firm of mining engineers in West Australia, every opportunity for developing the direct wood-gas producer. The result was a down-draught producer which uses the wood as it comes from the bush in 6 or 7 ft. lengths and up to 10 in. in diameter.

The first of the new producers was put in operation in 1913. Since that date others have been installed in many existing gas-power plants, and many new ones erected. After nearly two years experience and in view of the continued adoption of this producer on other West Australian mining properties and industries, it would seem to have made a permanent place for itself, and the inclusion of this type of gas producer in the equipment of most new West Australian mining properties now seems probable.

One effect of this provision of a cheap gas supply has been the adoption of gas engines at centres where, with charcoal producer-gas, the high-class condensing and steam engine had proved almost as good. Competition between steam and charcoal gas was only possible where an adequate supply of fresh water was available for the steam plant boilers and condensers. In localities where fresh water was difficult to obtain and salt water had to be used for steam surface condensers, the advantage was all on the side of the charcoal-gas engine, the reason being that where gas engines vary but little in efficiency, the steam engine depends greatly on the vacuum held by the condensing plant. This vacuum falls rapidly where salt water is used in the condenser cooling tubes, owing to the deposition of heat-resisting scale.

Questions regarding the reliability and continuous running of gas engines versus steam engines have long been a source of contention. The margin of difference on this score in favour of steam has been of late years reduced to a fine point. In this connection the record of an actual case of gas-engine performance might be of interest. The plant taken as an example originally had a 200 hp. gas engine driving the treatment plant on a gold mine. The capital available for the equipment of the property did not permit of any duplication of the power plant as a standby, and it had been proved at similar mines where the power was supplied by steam boilers and one main steam engine, that the latter was sufficient in itself for almost continuous night and day running without fear of serious stoppage. The only safeguard necessary was the addition of a spare boiler as a standby. The conditions of running were that the steam engine should work con-



Vertical Section of Gas Producer adapted for burning Wood in 6 ft. lengths.

tinuously for 168 hours per week; that is, 24 hours per day, with a predetermined stoppage of say 8 to 10 hours at the end of each month for general overhauling, and occasional stoppages during the month totalling not more than four hours. These occasional stoppages would not take the form of a sudden shut down, but would be arranged for some hours previous to the stop, so that the process of gold extraction should not be unduly interfered with. Under these conditions, the steam engine was required to be in operation 98% of full time. In order to obtain similar results with a gas engine and no standby, the stoppages had to be well planned and provision made ahead for any repairs and cleaning required. With the gas plant in question this was found possible. The result was that, month in and month out, 98% of full running time was realized.

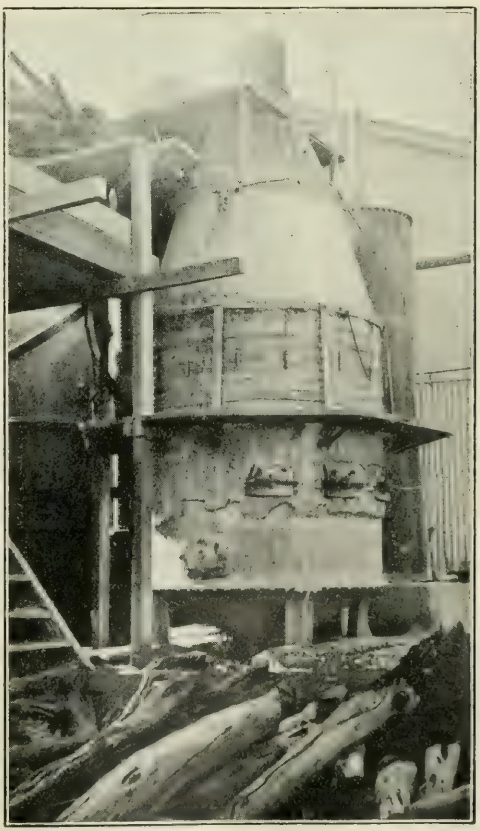
There is no doubt that the feeling against gas engines on the score of unreliability has been general, and while in some mining districts they have proved themselves almost as reliable as steam, and have been, and are being adopted in place of steam, there are other districts where the steam engine holds complete sway. In these districts local fuel supplies are being rapidly worked out with a corresponding rise in the cost of such fuel. In a mining district where wood fuel has been used for some years, the adjacent timber reserves have usually been denuded of all good steam-boiler fuel (such as logs of not less than 3 in. diameter by 6 or 7 ft. long), and the distances from which suitable wood fuel is now being hauled will be anything between 25 and 60 miles. A large tonnage of small timber close to the source of consumption is always available since, owing to its lightness, much of it being less than 2 inches in diameter, it is unsuitable for steam boiler purposes. This light wood, almost faggots, contains the same number of heat units per pound as the heavier fuel; but when burned in an ordinary grate under a boiler, bursts into fierce flame for a short time while the boiler is being stoked, only quickly to die down to glowing coals. The use of such a fuel causes great variation in the temperature of the gases passing through the boiler flues. The fire doors have to be opened much more frequently for stoking than in the case of the wood of larger diameter, with the result that immense quantities of cold air in excess of that required for combustion enter the fire-box, only to increase the draught and to carry out through the stack unused heat.

The above description suggests a query as to why in such cases the fire-box is not especially designed for the poor light fuel. The reason this was not done at the plant in question was that the larger wood was necessary in the roasting section of the ore-treatment plant where this steam plant supplied the power. In the roasting section, a steady flame was necessary so that arrangements had to be made for bringing in large fuel anyway, and it was more convenient to use the same wood under the boilers. The utilization of this small fuel could be achieved by making special fire-boxes and feeding arrangements for both boilers and roasters.

The wood-gas producer is in reality a type of fire-box for burning this small fuel, only the direction of the draught is down through the grate instead of up through it. Its advantages in a region of poor wood fuel for converting the wood into gas for use in gas engines is fully appreciated and the system is used in certain West Australian mining districts. Its further application to firing roasting furnaces for the desulphurizing of dry-crushed gold ores is now being made on one mine.

There is another possibility in power-gas work on which I should like to touch. The wood-gas producer mentioned is constructed on the down-draught principle, that is, the wood is fed in through the top of the producer and passes down until it becomes glowing coals on the grate. The air and steam necessary for gas making travel in the same direction, the resultant power-giving gas passing down through the grate and then on to the cooling plant.

The last contact this gas has with the fuel in the producer is with the glowing red hot coals on the grate. These glowing coals partly convert any volatile matter or tar remaining in the gas into 'fixed gas.' The other part of the tar and volatile matter (usually



Gas producer adapted for burning wood with down-draught and supplying power to a 200 hp. engine.
Note the wood in the fore-ground and at top, a sample of that fed to the producer.

about half) is destroyed, that is, burned in the producer. This means that the resultant gas contains little or no tar, and after passing through any simple cooling and settling plant is quite clean enough for gas-engine work; that is, for running a gas engine month in and month out, 98% of the full 720 hours of a 30-day month.

Bituminous coals, up to the present, are gasified in up-draught producers when used for gas engines. The direction of the gas through the fuel is in the opposite direction to that in a down-draught producer, with the result that the last contact of the gas is with the cooler portions of the fuel. In consequence of this a considerable amount of tar and volatile matter is carried over into the cleaning plant and must be separated before the gas is fit for use in a gas engine. While the up-draught producer is preferable where large power plants combine the recovery of by-products with gas production, the small plant of say 500 hp. downwards does not justify that additional capital expenditure necessary for the by-product plant. It is with the small bituminous coal suction, or suction-pressure, producer gas engine plant that the down-draught producer might be used. Here the user is not looking for a profit from by-products but is concerned solely in obtaining a smaller coal bill and cheaper up-keep of cleaning plant. Since a portion of the tar and volatile matter in the coal is converted into a fixed useful gas with the down-draught producer, the coal bill should certainly be less. The cleaning plant should require less attention since its main function will be to cool the gas and cleanse it from fine ash and carbon.

The advantages of using producers do not accrue alone when power is the object in view. A gas producer of the type I have described above has recently been applied in Western Australia to furnishing fuel for roasting gold ore in place of the ordinary fire-box. The result has been excellent. There was not only marked economy in the amount of fuel used, but the regularity of the heat made a more regular roast possible, and thus a better extraction in the treatment plant. Incidentally the smooth working increased the capacity of the whole plant.

Mines on the Battlefield.

Some idea of the work done by the Royal Engineers in connection with the mines driven from the trenches toward the German lines may be obtained by reading the records of the deeds which won special commendation. On October 2 the Military Cross was awarded to the following, among others, in recognition of their gallantry and devotion to duty.

Temporary Lieutenant THOMAS HAMILTON CARLISLE, 171st (Mining) Company, Royal Engineers; for conspicuous gallantry on the night of September 12, near Armentieres. With another officer he entered a mine, which was in a highly dangerous state at the time owing to gas fumes following an explosion, in order to rescue a man who had been overcome.

Lieutenant WILLIAM HAROLD HILLYER, 3rd London Field Company, Royal Engineers, Territorial Force (attached 171st Mining Company); for conspicuous gallantry and devotion to duty in mining operations at Hill 60, near Ypres, between April 2 and 17. The task of completing and charging one of our mines was one of great difficulty and strain. Lieutenant Hillyer worked and watched long hours at the end of a gallery 165 ft. long and 3 ft. by 2 ft. 3 in. in size, knowing that the enemy was countermining close by.

Temporary Lieutenant ERIC GUY SUTTON, 7th Battalion, the Royal Sussex Regiment; for conspicuous gallantry on the night of September 12, near Armentieres. With another officer he entered a mine, which was in a highly dangerous state at the time owing to gas fumes following an explosion, in order to rescue a man who had been overcome.

Temporary Second-Lieutenant FRED BELL, attached 173rd (Tunnelling) Company, Royal Engineers; for conspicuous gallantry and determination at Cambrin on September 6. After the Germans had broken through into one of our mining galleries he went down into the working under fire, cleared out the enemy with his revolver in the dark.

Temporary Second-Lieutenant ERNEST WILLIAM BYRDE, 173rd (Tunnelling) Company, Royal Engineers; for conspicuous gallantry and skill in France, when he was engaged in pushing forward advanced galleries through those of the enemy, thereby determining the success of the mining operations.

Temporary Second-Lieutenant RAYMOND BURKE WILLIAMS, 176th Company, Royal Engineers; for conspicuous gallantry and devotion to duty at Givenchy on August 25, when in charge of a mine. He went down the gallery immediately after the end had been blown in and ordered the men out owing to gas fumes. He then endeavoured to rescue the men till he was himself overcome by fumes, and had to be dragged out; but as soon as he recovered he again went half way down the mine and directed further rescue operations.

TIN AND TUNGSTEN IN THE WEST OF ENGLAND

J. H. COLLINS.

Cornwall and Devon have together produced at least 2,250,000 tons of tin, but conditions have changed materially since 1872 when out of a world's output of 18,544, Cornwall furnished 10,000 tons. Cornwall no longer dominates the market and must look carefully to costs. Further development of shallow mines is urged. Tungsten is becoming increasingly important in the West country and a list of occurrences is given. Oxland's process is described and custom works for its employment is suggested.

*TIN has been produced in our Western Peninsula, at first from alluvial deposits (stream works) exclusively, but later chiefly from mines, for more than 2000, and probably more than 4000 years, while the prehistoric bronze celts testify to the antiquity of tin 'smelting.'† Of the long period previous to the 12th century, little or nothing is known of a statistical character, though we are told of a ship laden with tin sailing from Cornwall to Alexandria "under the protection of an Angel" in Saxon times.‡ The author of an excellent work on the stannaries remarks, "It would seem that in 1156 the production of tin was small and for the most part confined to Western Devon. From 1156 to 1160 the tax on output, stated at 20d. per thousand weight in Devon and 5s. in Cornwall, was farmed by the sheriff of Devon for the annual sum of £16. 13s. 4d., showing a production of about 133 thousand weight of tin.§ Up to 1189 the 'farmer' seems to have received nothing from Cornwall and only £206. 7s. 4d. from Devon. In 1195 he got £53. 6s. 8d. from Cornwall and nothing from Devon; in 1197, £100 from Devon and nothing from Cornwall; and from 1200 to 1214 £66. 16s. 0d. from Cornwall and £100 from Devon. An attempt has been made to estimate the relative and actual tin production in the two western counties at this time by reasoning on these figures, but surely without any solid grounds since the returns are obviously too fragmentary, and certainly in no way exhaustive. In such unsettled times it is not at all likely that the majority of the tinners of Cornwall paid dues on their production to anybody, newly created Earl of Cornwall or otherwise.

The fact that at one particular epoch, and that the earliest recorded in our national archives, the Devon production seemed to exceed that of Cornwall, has led some writers to speak of Devon as a great tin-producing county. All the geological, and all later historical evidence goes to show the contrary. Indeed the tin-producing capabilities of Devon must always have been comparatively trivial, and for some centuries past it has yielded less than 2% of the West Country tin. Mr. Robert Hunt, after an elaborate review of the abundant materials at his disposal, gave many interesting details of tin production in his 'British Mining,' and finally arrived at an approximation, sufficiently close to enable us to say that upwards of two million tons of metallic tin had been extracted from our stanniferous deposits up to the year 1880. He gives the following detailed figures†:

	Tons.
In the 500 years B.C.*	50,000
In the 500 years of Roman occupation	50,000
To 1066 (the landing of William the Conqueror)	100,000
To 1300 (Edward I)	369,800
To 1500 (Henry VIII)	42,048
To 1600 (Elizabeth)	680,100
To 1636 (Charles I)	30,000
To 1740 Computation of Mines Royal Co.	235,000
To 1834 (William IV)	202,000
To 1860 (Victoria)	162,000
To 1880 (Do.)	195,223
Total	2,116,171

Mr. Hunt's figures are now more than 30 years in arrear. From the 'Mineral Statistics' we learn that from 1881 to 1910 inclusive, the production of *black tin* was 318,780 tons, equal to 212,520 tons of metal. Adding this to Mr. Hunt's total we get a grand total of 2,228,691 tons to the end of 1910. It is fairly certainly the case that even this large figure is considerably below the truth. I have already referred to the incompleteness and fragmentary character of the ancient records. The records from 1801 onward are as under:

	Tons.		Tons.
1801—1810	43,316	1861—1870	130,815
1811—1820	48,694	1871—1880	145,412
1821—1830	62,936	1881—1890	142,540
1831—1840	61,472	1891—1900	101,965
1841—1850	80,198	1901—1910	74,275
1851—1860	96,572		

*From an address delivered before the Falmouth Meeting of the Royal Cornwall Polytechnic Society.

†See 'The Cassiterides' by Dr. George Smith and 'The Antiquity of Mining in the West of England' by R. N Worth.

‡R. Hunt, 'British Mining,' p. 817.

§'The Stannaries' by G. Randall Lewis, 1908.

*Tin was probably produced and exported to no inconsiderable extent much more than 1000 years B.C.

†'British Mining' 1884, p. 823. (The figures given in the book are wrongly added).

Even these are seriously incomplete for the first fifty years or so. The 'Mineral Statistics' were begun in 1848, though the tin statistics began only in 1852, Balleswidden then leading with 465 tons of black tin and Polgooth coming next with 355 tons; such mines as Dolcoath and Botallack not being reported at all. In the very next year, however, Dolcoath leads with 360 tons and Botallack records 147 tons. The fact is that the returns were for a long time purely voluntary, and even now the mines are not obliged to report values. However, accepting the figures quoted above as approximately correct—over two and a quarter millions of tons — the actual metallic content of the ores must have been considerably more than three million tons, since it is well-known that by our mechanical methods the average recovery does not exceed 70% of the tin present in the ore; often indeed, it is much less than this, owing to the presence of stannite, a mineral in which the tin is combined with copper and sulphur, the whole of which is lost in the ordinary tin-dressing process. I doubt whether there has been much real improvement in tin saving during the past thirty years notwithstanding the large expenditures incurred in providing up-to-date and expensive machinery. In our deeper mines the particles of cassiterite as they exist in the stone are so small that unless the ores are very finely divided many of them must escape in the sands, while on the other hand if they are very finely reduced a good deal must escape in the slimes. I made many microscopic slides of Cornish tinstones nearly 40 years ago and published my results in a work which is now long out of print.* Many particles of cassiterite were seen whose largest dimension was less than $\frac{1}{10,000}$ of an inch. The advantages of 'stage-crushing' are now generally recognized, but without fine reduction I believe the dressing losses would be greater than they are at present. Many attempts have been made to recover the whole of the tin present by chemical methods. Some of the experiments have a very promising appearance, but so far it must be said that they have not been economically successful.

The production of black tin reached its maximum in 1871 when 16,272 tons were raised and sold at the average price of £78. 12s. 6d. per ton. Of late years, it has been less than 8000 tons per annum. How far this falling off may be taken as an indication of exhaustion in depth cannot yet be fairly discussed. Doubtless there are vast quantities of tin yet to be won in every one of the many recognized tin-mining districts, most of which have been nearly or entirely neglected for a generation or more. Until these have been fairly and fully tested to a depth of 500 fathoms, it is too soon to begin to talk of a lower limit for tin analagous to the known lower limit for copper. But far too much has been spent in reopening and elaborately equipping old and deep mines and too little in reworking mines of moderate depth, or in seeking for new deposits in known good districts, such as St. Austell, Liskeard, and Callington.

When I first began to take an interest in tin production, the conditions were altogether different from those prevailing at present. In 1872 the total production of the world was 18,544 tons, of which Cornwall, with a very little help from Devon, gave nearly 10,000 tons.* The present world production is much more than 100,000 tons annually, of which we produce less than 5%. Furthermore, a notable proportion of the world's production during the first two-thirds of the 19th century was still obtained by actual mining. Since then alluvial mining has become by far the most important source of tin. In consequence of these changes the Cornish market, which once practically controlled prices, has now hardly any influence at all. We may produce or not, as we please, but we have to accept what others choose to give us for our produce. This would not matter so much to us were the prices moderately constant. But, when to the ordinary uncertainties of mining we have the equally great uncertainties as to the value of our product, it will be admitted that, although the profits have often been great, the anxieties of those in charge of tin-mining operations in a region where rates, taxes, insurances, and royalties are steadily increasing, must be greater still. Certainly the persistence of tin-mining in the West of England is one of the most remarkable examples of tenacity and perseverance to be found in the world. There is much suggestive force in the old proverb, "When a tinner's broke, his neck is broke." Nothing short of that will permanently put him down. Of that I am as much persuaded as I was when I became the secretary of this Society† nearly forty years ago.

Tungsten is far rarer and far less widely distributed than tin in the West of England. It is altogether absent from the lead veins, from most of the copper veins, and from very many of the tin veins, while as a rock con-

*'Cornish Tinstones and Tin-capels' Truro. 1888.

*Hunt, 'Report of the Miners' Association of Cornwall and Devon,' 1874.

†The Royal Cornwall Polytechnic Society.

stituent outside the veins it has not been found at all. In the form of wolfram, which is a tungstate of iron and manganese containing about 60% of tungsten, it is locally somewhat abundant as at East Pool, South Crofty, North Tincroft, and other places in the parish of Illogan. Some tons have also been obtained within the past decade from the eluvium on the slopes of Buttern Hill in the parish of Altarnum, as described by Mr. Geo. Barrow.* A full list of its West of England localities is given in an appendix. Scheelite, a tungstate of lime, has also been found in the Bedford United and a few other mines in the West of England, but nowhere abundantly. Wolfram ochre (wolframite) has also been found in minute quantities in most of the wolfram localities. But of these tungsten minerals wolfram alone has been met with in quantities of economic importance.

The first mention of tungsten in the official 'Mineral Statistics' was in the year 1858, when tungstic acid and tungstate of soda were being prepared and sold from the tin-ores of Drakewalls and Kit Hill; details of quantities and values, however, were not given until the year 1859 when 26½ tons of "tungsten" were reported as sold from Kit Hill United for £293. Small quantities of tungstate of soda and tungstic acid were subsequently sold from Kit Hill, Trebartha-Lemarne, East Pool, and other mines—perhaps 20 tons in all, but generally the tungsten ore was sold as Wolfram, as under:

		Tons	Sold for £
1855–60	Kit Hill	46	312
1861–70	,,	51	653
,,	East Pool	79	537
1871–80	,,	269	2,971
,,	Kit Hill	15	164
,,	South Crofty	14	98
1881–90	East Pool	1006	15,484
,,	Herodsfoot	5	49
,,	Holmbush	3	30
1881–90	Wheal Agar	3	45
,,	South Crofty	3	5
,,	Trebartha-Lemarne	14	351†
1891–1900	East Pool	509	14,307
,,	South Crofty	2	10
,,	Carn Brea	329	14,710
,,	East Kit Hill	11	528
,,	Gt. St. George	2	33
,,	Wh. Gorland	20	60
,,	Bedford United	1	39
,,	Sundries	8	463
		2,390	50,849

*Q. J. G. S., XLIV, p. 387, 1908.

† Tungstate of soda.

		Tons	Sold for £
1901–10	East Pool	478	38,948
,,	Carn Brea	105	8,512
,,	Clitters (1903–9)	249	21,172
,,	Bunny (1903–7)	81	4,897
,,	S. Crofty (1905–10)	444	44,632
,,	Hingston Downs (1905–8)	118	12,617
,,	Gorland (1906–10)	193	16,934
,,	Bedford United	30	1,840
,,	Red Moor	2	240
,,	Friendship (1909)	1	45
,,	Drakewalls (1910)	1	59
,,	Good Fortune (1903)	2	58
,,	Buttern Hill and other stream works	47	3,703
,,	Sundries not specified	366	27,351
		2,167	181,008

In a few instances the values here given are estimated but probably very near the truth.

Thus then, from 1855 to 1900 the quantity of wolfram (and a little tungstate of soda) sold was 2390 tons, value £50,849, or something over £21 per ton, while from 1901–10 the sales were 2117 tons which realized £181,008, or over £85 per ton. In 1911 the total sales were 266 tons realizing £25,629, and in 1912, 193 tons realizing £16,953, or over £90 per ton. These are the latest of the official statistics, but I have been able to obtain the statistics of East Pool and South Crofty for two years later, as under:

	East Pool.		South Crofty.	
1913	45½ tons	£5,036	115½ tons	£10,805
1914	107½ ,,	£11,113	66 ,,	£5,770

The sales for 1915 are likely to be considerably larger and probably at higher prices. The demand for wolfram and the price paid for it has been steadily increasing for the past 25 years. It is no longer obtained exclusively from the West of England; in fact, the world's production greatly exceeds that of our region. At present good wolfram is worth nearly £200 per ton.

The simple mechanical treatment of tin-wolfram ores is by no means satisfactory, since the concentrates rarely contain more than about 70% of the tin and 50% or less of the wolfram originally contained in the ore. Having obtained the mixed concentrates, they can be separated (though imperfectly) by means of the Wetherill magnetic separator; the wolfram so separated, however, still contains a notable proportion of tin, even when the mixed concentrates have been 'pickled' in hot dilute sulphuric acid before being magnetically separated as in the process employed at the East Pool mine. Although the treatment adopted during the past decade at this mine has proved to be a great advance on what had been done for many years previously, yet there is still room for improvement, since the loss of the wolfram in the earlier stages of treatment is excessive, while the purified tin oxide still contains some traces of tungsten; enough at any rate to prevent its being sold as black tin of first rate quality. I have always been in favour of the adoption of Oxland's process for the treatment of tin-wolfram ores after their first concentration and calcination into what is called 'burnt-whits,' since it secures the recovery of a very high proportion of both the tin and tungsten present in very pure forms. This process was invented and patented by an old friend, Dr. Robert Oxland, now many years deceased, about the year 1844. It was soon after introduced at Drakewalls and Kit Hill mines in East Cornwall and much later at the Trebartha-Lemarne mine where it continued in use until the year 1889. In a small and very experimental way it was also employed at East Pool where I saw it in operation about the year 1870.

The 'burnt-whits' are buddled or tabled to get rid of silica or other light waste, mixed with soda-ash in the proportion of about 50% of the wolfram present, and heated at a proper and considerable temperature in a reverberatory furnace for several hours, being frequently stirred during the process, thus converting the wolfram (or scheelite if present) into tungstate of soda. When this process is complete, the mass is thrown into lixiviating vats, and the solution formed is drawn off into evaporating pans where the tungstate of soda is crystallized out. The tin present can be easily separated from the insoluble mass after pulverization by any of the usual methods and in a very pure state. The tungstate of soda—for which twenty years ago there was very little demand—is now readily saleable at high prices, since the tungstic acid present in it is readily separable by means of hydrochloric acid. Of course, the adoption of this method of treating tin-tungsten ores would necessitate a considerable outlay in plant and also regular chemical supervision. It would probably be best for the leading mines producing tungsten to combine in some way for the erection of such a plant and to purchase tin-tungsten ores from the smaller producers in their crude state. If they could do the same for the whole of their tin production, I believe it would prove very advantageous for the tin mines of Cornwall.

The following list of mines and localities includes all known to me which have yielded ores of tungsten (chiefly wolfram) in the West of England:

Agar, Wheal
Beam (Great Beam)
Bedford United
Botallack
Bunny (Shelton)
Bunny, North (specimens only)
Carn Brea
Cligga Cliffs (specimens only)
Crofty, South Wheal
Dolcoath (specimens only)
Drakewalls
East Pool (wolfram with small quantities of scheelite and wolfram ochre)
Fanny, Wheal (specimens only)
Fortune, Great Wheal (specimens only)
Friendship, Wheal ,,
Godolphin Bal ,,
Gorland, Wheal
Gunnislake (specimens only)
Harmony, Wheal ,,
Herland ,,
Herodsfoot
Holmbush
Kit Hill
Kit Hill East
Latchley, Wheal (specimens only)
Maudlin ,,
Metal, Wheal ,,
Pednandrea ,,
Poldice
Pengelly Croft (wolfram and scheelite, specimens only)
Prospidnik, Wheal
St. George, Great
St. Michael's Mount (specimens only)
Stenna Gwyn (specimens only)
Tincroft
Tincroft, North
Trebartha-Lemarne
Buttern Hill, Red River, and other 'streamworks.'

Meteors Found in Klondyke form the subject of Museum Bulletin No. 15, issued in June by the Geological Survey of Canada. In this bulletin, R. A. A. Johnston describes two meteors, consisting mostly of iron, found in the course of mining operations in Gay and Skookum gulches, tributary to the Bonanza creek system in Klondyke region. These are preserved in the Ottawa Museum. The first, found in Gay gulch in 1901, weighs a little over a pound. The second, found in Skookum gulch in 1905, is much larger, weighing 35 lb., and measuring about 11 in. by 9 in., and from 1 to 3 in. in thickness. The characteristics of the two meteors show great similarity. Both are exceptionally rich in nickel. The positions in which they were found were similar, both lying on the bedrock under the 'white channel' gravels, that is, the ancient creek deposits. The author concludes, for these reasons, that both were relics of a single meteoric shower that occurred in Tertiary time.

INTERNATIONAL ENGINEERING CONGRESS.

The International Engineering Congress was held at San Francisco, from September 20 to 25. Owing to the European war, the international character of the meeting was greatly restricted. Very few visitors came from Great Britain, Africa, or Australia. French, Belgian, and Russian engineers were otherwise engaged, and Germans and Austrians were absent. American engineers however made extra efforts to make the Congress a success, and they were assisted by Japanese, Dutch, and Italian visitors. The fact that the International Mining Congress, which was to be held in London this year, had to be abandoned naturally provided the opportunity for mining engineers and metallurgists to take a larger share in the proceedings of the Engineering Congress, and their sections provided an unusual amount of interest.

In the Mining Engineering section, one session was devoted to the subject of valuing mines, and the following papers may be noted: Valuation of Metal Mines, by T. A. Rickard; Valuation of Oil Lands and Properties, by M. E. Lombardi; Valuation of Coal Mines and Lands, by R. V. Norris; Valuation of Coal Lands, by S. A. Taylor; Valuing Coal Properties in Western Canada, by R. W. Coulthard; Valuation in France, by E. Gruner. At a second session the following papers formed the basis of a discussion on company management: Functions of Exploration Companies, by H. W. Turner; European Mining Finance, by J. H. Gallard, of *The Financial Times ;* the Financing of Mines in the United States, by Lucius W. Meyer. The third session was devoted to papers on certain economic aspects of mining: Organization and Staff of Mining Companies, by W. H. Shockley and R. E. Cranston; Relations of Governments to Mining, by Horace V. Winchell; Mine Inspection, by J. W. Paul.

In the section devoted to Metallurgy, the first session was devoted to iron and steel. The second and third sessions were devoted to copper, and was under the general direction of E. P. Mathewson, of Anaconda. The following papers were presented: Progress in Copper Metallurgy, by Thomas T. Read; Advances in Copper Smelting, by Frederick Laist, of Anaconda; Metallurgy of Copper in Japan, by R. Kondo; Copper Metallurgy in the Southwestern States, by Dr. James Douglas; Reduction Works of the Copper Queen, Arizona, by Forest Rutherford; Advances in the Metallurgy of Copper in the Globe District, Arizona, by L. O. Howard; Improvement in the Design and Construction of Modern Copper Plants, by Charles H. Repath; Boronized Cast Copper, by E. Weintraub, of West Lynn, Massachusetts; Electrolytic Refined Copper, by A. C. Clark, of the Raritan works; Development of Electrolytic Copper Refining, by Lawrence Addicks; Physical Properties of Copper, by C. R. Hayward, of the Massachusetts Institute of Technology. The fourth session of the section was devoted to gold and silver, and was under the direction of C. W. Merrill. The following papers were presented: Coarse-Crushing Plant, by G. O. Bradley; Crushing and Grinding, by L. D. Mills and M. H. Kuryla; Solution of Gold and Silver, including Classification, by M. H. Kuryla; Filtration or Separation of Metal-bearing Solution from Slime Residue, by L. D. Mills; Precipitation, by G. H. Clevenger. At the fifth session, the metallurgy of zinc and lead, fuel questions, and ore-dressing were included in the discussion, and the following papers were read: Economics of the Metallurgy of Zinc, by W. R. Ingalls; Development of Zinc Smelting with United States, by George C. Stone, of the New Jersey Zinc Co.; Smelting and Refining of Lead, by H. O. Hofman; Pulverized Fuel in Reverberatory Furnaces, by D. H. Browne, of the Canadian Copper Co., and by E. P. Mathewson, of Anaconda; Gas Producer Development, by Z. C. Kline; Surface Combustion, by C. E. Lucke; Ore Dressing, by Robert H. Richards.

Another section of interest to mining men was that devoted to Materials of Engineering Construction. Among the papers presented may be mentioned the following: The Outlook for Iron, by James F. Kemp; Consumption of Copper and its Various Uses, and the Economics of the World's Supply of Copper, by Thomas T. Read; the Engineering Uses of Aluminium, by Joseph W. Richards; Alloys and their Use in Engineering Construction, by W. R. Webster, of Bridgeport, Connecticut.

As the Panama Canal is the greatest of recent civil engineering triumphs, it appropriately received first attention in the consideration of Waterways, and the following papers were presented: Introductory Paper, by G. W. Goethals; Commercial and Trade Aspects of the Canal, by E. R. Johnson; Outline of Canal Zone Geology, by D. F. MacDonald; Climatology and Hydrology of the Canal, by F. D. Wilson; Dry Excavation, by G. W. Goethals; Dredging in the Canal, by W. G. Comber; and several others.

DISCUSSION

Helping the Empire.

The Editor:

Sir—The letter of Mr. J. H. Curle in your last issue is written in such an excellent spirit and in its method and matter is such a stimulating contribution to the subject of the country's need, that I am rather reluctant to attempt any destructive criticism of the fundamentals upon which he bases his argument. At the same time, I do not think that all that he says should pass unchallenged, lest some may lose heart without good cause. It is right to take measure of the power of the enemy at its true value, but not to over-estimate it. I think that in some respects your correspondent has magnified its dimensions.

In the first place I do not like Mr. Curle's implied definition of 'capital.' He speaks of German capital "circling round and round in Germany" while "British capital is going out of the country." Is that true? The purchasing power of the German people is necessarily, owing to her loss of the facilities of sea transport, exercised for the most part within her own country, while the purchasing power of the British people is exercised all over the world. This fact results in a loss of economic power to Germany and in a gain to that of Britain. Germany would speedily extend her trading area if it were possible for her to do so: because she cannot, she suffers a deprivation which Mr. Curle apparently regards as resulting in a conservation of her capital. I think, on the contrary, that the shortage of raw material and other products from abroad must have resulted in a large shrinkage of the capital value of her possessions. Capital is not money, but goods, and Germany's capital, consisting of factories, ships, means of distribution, and even her cultivated land, are suffering a contraction of productive power which makes for impoverishment of the country and is, I think, accurately described as amounting to a capital loss. This is a loss from which Britain is not suffering to anywhere near so great an extent.

At the same time it is not difficult to understand what Mr. Curle has in his mind. There is always a greater danger of currency troubles when there is exchange with other nations than there is within a self-contained community, and I quite agree that it behoves us to exercise thought and care lest by unwise and thriftless expenditure we are deprived of the advantage of our world-wide trading and perhaps reduced to the importation of necessities only. At the worst it seems to me that our position, so long as we hold command of the seas, can never be so bad as that of Germany in this respect. Whether we are as well disciplined as the German people in regard to adaption to such impoverished circumstances is another question. We have not yet been put to the test as we have not felt the pinch, nor are we likely, I think, to feel it for a long time to come. We are meeting a large part of the cost of the war out of capital; so is Germany. In both countries the demands of the war have brought about a cessation of the process of the creation of capital (capital can only be created by producing more than is consumed), and consequently there is a demand for a fuller utilization of our existing capital resources.

If we will keep distinct in our minds the specific difference between capital and money, we shall, I think, see that, as regards capital, our position was stronger than that of Germany at the outbreak of the war and that circumstances are enabling us to make a fuller use of the larger capital we possess than Germany can of her smaller store. And that, as regards money—the mechanism of finance by means of which exchange is effected — our position is greatly superior to that of Germany both in respect to facility and in respect to safety, and is likely to remain so. Germany shows recognition of the weakness of her position by the efforts she has made to create a store of gold. She has created an immense amount of money by pledging securities with the result that while the capital value of her wealth has fallen the money based upon it has increased enormously. Such a process amounts to an inflation of currency which, were it not for the patriotism of the people, might bring about a crisis at any moment. When the war ends this paper currency must fall heavily in value (unless re-inforced by indemnities) and those who hold it at that critical moment will suffer a loss proportional to their holding. Germany has had no choice but to take this course; we may be compelled to follow along the same road, and we have done something in that direction already, but our financial strength should remain to the end relatively stronger than that of Germany. It is much more reasonable for Britain to adopt the high strategy of bleeding Germany white than that Germany should attempt to subject us to such a process.

But, while I regard Mr. Curle's premises as being in some respects faulty, I, nevertheless, heartily agree with his conclusions. None of the other belligerents are imposing war taxes; we have done so in a small, and we must do so in much greater measure. I wish that we had begun earlier. By organized saving (taxation) we can maintain, and perhaps increase, our present high standard of utilization of our great capital possession. I believe that we are prepared and ready to make the sacrifice. To many the contribution will be a satisfaction rather than a pain.

As M. Emile Boutroux has finely put it, "the war teaches us power through necessity." There is in our midst, I believe, a good leaven of the kind of spirit Mr. Curle has shown in his letter and in his active participation in "helping the Empire." Lovers of their country will be glad to live to see the day when the realization of necessity has been interpreted in the exercise of a power before which the great strength of the enemy must at length yield.

EDW. W. COWAN.

London, September 21.

[The differences between money, securities, and capital are, as our correspondent suggests, to be kept in mind. Accepting his definition of capital as goods, it must be clear that accumulated wealth, if it be of value, must represent goods except in so far as it be in the form of gold, which, after all, is one form of goods. The greater part of the accumulations of a nation is really in the form of securities which represent goods or plant at home or abroad. Germany is in position to utilize to the fullest extent all the goods and plant at home, as are also the Allies; but, to the extent that German-held securities represent goods and plant abroad, Germany cannot use such goods and plant. Thanks to the British Navy the real plant and goods representing the securities held by nationals of the Allies in any part of the world outside enemy countries, are potentially available for national uses. To the extent that the money is invested in munitions plant, shipping lines, or manufacturing, it is almost as freely available as if it were invested at home. Where the securities represent land or other property not directly useful, they may be made the basis of credit for purchase of goods more desirable. In effect this amounts to a temporary exchange of property, and the result is the same whether the property so exchanged be situated at home or abroad. By the fortunes of war Germany may only use the property available within her borders. She may neither use German owned property abroad, nor exchange home property not available for war purposes for foreign plant or goods more suited to immediate needs. She is forced to use to the fullest possible extent her home property. The Allies can do the same; and they have enormously greater resources, as it cannot be doubted that the amount of plant and goods suitable for war purposes outside the German lines is greater than that within. Potentially all this is available for the Allies, but it is only potentially so. British citizens own large blocks of shares in the Pennsylvania Railway, in California oilfields, in Chinese coal mines. This, however, will have no bearing upon the war unless such securities (representing goods) be exchangad temporarily or permanently for other plant and goods needed for ending the war. Wealth alone will not avail, nor will the handicap under which Germany is placed by British naval supremacy end the war, unless the peace resources of the Allies as well as those devoted in advance to war purposes, be placed at the service of the nations concerned. It is notorious that Germany had for years devoted a large part of her energy to the building of plant and making of goods for war. The Allies, on the other hand, in order to compete must convert to war purposes goods and property that in happier times are devoted to other uses. Whether wealth be considered as money or as the real goods and plant back of money, wealth without the spirit of sacrifice will not avail. If we look upon the war as merely a convenient season for establishing trade rights, a time for earning higher wages so that we may work fewer hours and drink more beer, a convenient season for enlarging our plant and harvesting extra profits, we shall fail, and deserve to fail. If, however, winning the war be put first, and profits, property, and commissions, as well as personal service, be put at the service of the Government, there can be no question as to the result. Britain is on trial, not as to the amount of her wealth of material, but of spirit, and it is to the spirit that Mr. Curle calls.—EDITOR.]

Caving Methods of Mining.

The Editor:

Sir—I have read your brief but interesting review of 'Caving Methods in Mining' in the July number of the Magazine, in which you mention a system or method employed in Spain at the Cabezas del Pasto mine. As this system has come under my personal observation on more than one occasion, and possesses features distinguishing it from other caving methods, perhaps a brief description may not be without interest to your readers, and may add a little to the common reservoir of knowledge to which all mining engineers should contribute, as you suggest. The method referred to was first introduced in Spain by Mr. C. Roepell at the Cabezas del Pasto mine and has been described by Mr. G. D. Delprat in a paper published in the *Transactions* of the American Institute of Mining Engineers for 1892. The same method was subsequently adopted in working the Mountain Copper Company's cupriferous pyrite deposit in Shasta County, California, in 1895, then under the direction of the late Mr. Alexander Hill. At a later date it was employed in working a similar deposit at the Esperanza mine in Spain under the management of Mr. T. D. Lawther. It is a system of mining particularly applicable to the economic extraction of ore from wide lodes and ore deposits which cannot be mined by open-cut or quarrying methods, and has distinct advantages over the pillar and stall system.

This method of mining cannot be strictly termed a caving method, since no actual caving of either the ore or surface of the ground occurs. Briefly, it consists in cutting horizontal slices of ore out of the orebody, and filling the vacant spaces with waste rock, usually brought from the surface for the purpose. As described by Mr. Delprat the *modus operandi* is as follows: The horizontal boundaries of the orebody are first determined on the various levels on which it is intended to commence working, an extraction shaft is sunk in the hanging wall of the lode from which cross-cuts are driven up to the ore, the first cross-cut being about 70 ft. below the top of the orebody, the next cross-cut being the same distance below the first and so on, to whatever depth the ore is found workable.

From the cross-cuts a narrow drift or level is run along the hanging wall following the sinuosities of the lode throughout its length, and from this drift cross-cuts are driven at equal distances of 30 ft. apart right across the orebody up to the foot-wall. The horizontal limits of the mass of ore are thus determined at each level or floor as it is opened up, preparatory to commencing extraction.

In addition to the narrow drift run along the hanging wall of the lode to determine the length of the orebody, a larger drift or gallery is driven in the hanging wall at a distance of about 15 ft. from the lode and more or less parallel with it. This gallery serves for tramming the ore from any part of the lode to the shaft on the particular level it is driven on. The narrow drift first driven along the hanging wall is not suitable for an extraction gallery, and is filled with waste rock after the final slice of ore is removed from that level.

When the first cross-cuts have been driven from the narrow drift across the orebody to the foot-wall, they are filled with stone, and new cross-cuts are then driven alongside the first ones; these are again filled up, and again new cross-cuts are driven and so on until a complete slice of ore has been removed over the whole length and width of the orebody. A new drift is then run along the hanging wall immediately above the first, which is filled with rock as mentioned, and from the new drift cross-cuts are again driven across to the hanging wall and the ore extracted in the same manner as from the slice below.

The first slice had of course to be broken out of the solid ore, while the second and succeeding slices above are undercut over the whole area, the actual ore settling down and resting on the packing. The extraction of the ore from the second and upper slices is therefore about 50% cheaper than from that of the first slice, as shown by Mr. Delprat, who compares the relative cost of mining under this system with that of the pillar and stall method, showing the latter to be about 25% greater. A further advantage is the complete removal of the whole of the ore from the lode in a safe and economical manner, practically without the use of timber and without actual caving of the overburden or surface.

A. G. WHITE.

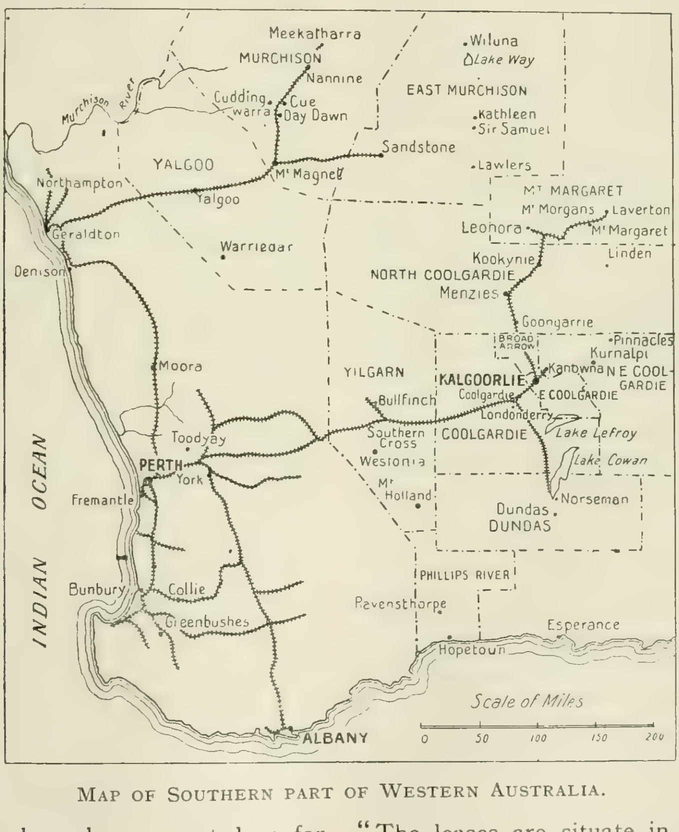
London, September 6.

[This method seemingly could not be used, or at least would not be economical, if the ore were so soft or so weak as to crush. Indeed at the Cabezas del Pasto the packing is all done with relatively large stone sent from the fine surface. Packing with 'smalls' leads to too much subsidence. The economy, amounting to 13d. per ton, as Mr. Delprat is careful to state, as compared with pillar and stall work, is due to the large part of the blasting that is done to free face.—EDITOR.]

SPECIAL CORRESPONDENCE

WESTERN AUSTRALIA.

THE splendid rains which have fallen all over the various mining fields and agricultural districts of Western Australia have made it an ideal year for prospecting, as it enables the parties to get out into the country which for some years has been too dry to provide feed and water for the prospectors' horses. Already several new finds have been reported, so far however sufficient work has not been done on any of them, to give any idea as to their extent or value. Considerable prominence has been given to a new belt of country which is situated between Southern Cross and Ravensthorpe, and about twenty miles to the south of Mt. Holland, a well known landmark, and which gives its name to the find. Gold was discovered some three months ago by a party of prospectors who pegged out a number of leases, and on their return to Southern Cross to report their discovery, many wild rumours were spread abroad as to the number and the great extent of the lodes. The Mines Department with commendable promptness sent one of the members of the Geological Survey to inspect and report on the possibilities as soon as possible. This report has now come to hand and, inter alia, Mr. Blatchford says:



MAP OF SOUTHERN PART OF WESTERN AUSTRALIA.

"The leases are situate in granite country, apparently a portion of the main granite belt. Lying to the northeast of the leases is rather an extensive belt of greenstones of the Marvel Loch type and probably a continuation of the same belt. Very little development work has been done on any of the leases and to date only one reef can be positively said to exist. The indications from quartz float, however, would point to the possibility of other veins being exposed at an early date. There is a marked parallelism of five lines of float, the general strike being N. 70° W." Float has been traced on the prospector's reward lease for a distance of over 700 ft., and this together with float on what are known as the Premier, Commonwealth, Potosi, and Allams Find lines of reef was crushed and panned by Mr. Blatchford and found to be goldbearing, but in his opinion were low and scarcely profitable. He further says that "it seems probable that higher estimates and value than justifiable have been given by prospectors on account of the low value of the gold bullion not being taken into account. Taken as a whole the reports of the field have been very much exaggerated, and against such the public should be warned. On the other hand, gold has been found over an extensive area in new country, and as practically no development work has been done, the expenditure of a limited amount of capital is justifiable."

A common-sense report like this must have a most beneficial effect, as it will help to impress upon those who find the means to carry out prospecting work, and also those eager speculators who do not like to miss the chance of a sure and easy fortune, the value of reliable technical advice, against the optimistic reports of interested men of no professional standing. The latter have been and still are to this day a curse to West Australian mining. Leases on which little or no development work has been done, but which are in the vicinity of a producing mine, are secured on option by some enterprising commission agent, who passes it on to a promoter. The latter arranges for a report by a man whose optimism can always be depended upon, and the company is floated with a great flourish of trumpets, but as a rule with very little working capital, the result being that in a few months time the company is in liquidation, and has virtually nothing to show for the money subscribed by the credulous shareholders. It is pleasing therefore to contrast this with the method adopted at Warriedar, a new field on the Murchison goldfield near Yalgoo. In this case the prospectors dealt directly with an English company, on an option which allows the latter to develop the mine and erect a plant thereon to treat the ore developed before purchase, not after. The money so expended goes to test the possibilities of the mine, and even should it prove to be too small for the company, the prospectors have the advantage of the development work done, and at least some ore ready to be stoped, together with knowledge being gained as to whether it will pay them to develop it further or not.

The field which has been much before the public during the past year is Westonia, in the Yilgarn goldfield. There have been a number of companies formed on the strength of the success of the Edna May mine, which together with the Edna May Central are the only producing mines at that centre. The lodes in these two mines occur in an isolated lens of gneissic granite, and are most peculiar in strike, which varies from N. 73° W. in the Edna May Central ground, sweeping round to N. 30° E. on the Edna May and gradually to one of N. 70° W. where the foot-wall of the lode is greenstone. The lode in the Edna May mine is in places 40 ft. wide, and consists partly of quartz and partly of kaolinized material, though the eastern portion may better be described as a succession of lenses and bands of quartz mixed with kaolin and country rock. The hopes of all the mines at Westonia are centred in the 300-ft. level of the Edna May mine; the cross-cut at that level should have cut the lode before this, but owing to a heavy inflow of water, it has not been possible to continue the cross-cut until a larger pump has been installed. The experience of the Yilgarn field has been that from this depth there has been a general impoverishment of the lodes. The officers of the Edna May company have sufficient faith in that mine proving the exception to the rule to double the capacity of the treatment plant.

Great interest is being taken in the reopening of the Lancefield mine at Laverton, new capital having been found by several Western Australian mining engineers, who have placed Mr. George Ridgeway, lately the assistant general manager at the Great Boulder mine in charge. There seems to be no doubt as to the quantity of ore available in this mine. Hitherto the difficulty has always been that the plant was not able to run with sufficient continuity to treat the requisite tonnage. If the ore was rushed through the extraction fell considerably, so that when break-downs occurred, which were not seldom, it was necessary to sacrifice extraction or put through a smaller tonnage. Unfortunately in cases where the mine superintendent is not in direct touch with the Board of Directors, he generally has to adopt the former method, as he is not in the position to explain to the Board that to prevent a rise of say sixpence per ton in his costs, he has had to lose nine pence per ton in his extraction. Mr. Ridgeway has re-organized the plant, and being in close touch with his confreres on the Board, he can deal promptly with any difficulties that may arise. He has a big problem, and he carries with him the best wishes of his fellow mining men of the state.

What may develop into an important industry, is the mining and treatment of magnesite, to convert it into epsom salts, as owing to the supplies of the latter being taken over by the Government in England, the price in Australia has increased enormously. A lot of this magnesite from a deposit near Kalgoorlie is being sent to Melbourne for experimental purposes, and there seems to be no reason why it should not be made a commercial success.

LEEDS.

THE MEETING of the Institution of Mining Engineers held on September 15 and followed on the next day by excursions to the Maltby Main and Bentley collieries, was well attended despite the all-prevading influence of the war. Only one session was held for the hearing of reports and the reading of papers, and the dinner of the Institution was entirely informal. In reporting on the negotiations for the Charter, the president, Sir Thomas Holland, paid a high compliment to the Institution of Mining and Metallurgy among others, stating that it had acted in the fairest possible manner throughout the negotiations incident to defining the scopes of the two institutions. Under the arrangements resulting the Institution of Mining Engineers is incorporated "for the advancement of coal and iron mining and allied industries, more particularly in relation to stratified deposits," while the Institution of Mining and Metallurgy is devoted to the mining of minerals other than coal and the metallurgy of metals other than iron. As the two Institutions received their charters on the same day Sir Thomas suggested that hereafter they were not only "sister societies," but "twin sisters."

The feature of the meeting was the presentation of the gold medal of the Institution to Dr. John Scott Haldane, this being the second occasion upon which the medal had been given. The first recipient was Sir William Garforth. In making the presentation Sir Thomas called attention to the wide value of Dr. Haldane's work, benefiting, as it had, not only mine operators but the men as well, and not only colliers but metal miners. He suggested that it might well be a matter of pride to Dr. Haldane to reflect that there are hundreds of industrial workers who, except for his work, would not now be among the living. Dr. Haldane's work had value as a contribution to science, and he was fortunate also to have seen its wide application in industry. Reviewing briefly the main features of Dr. Haldane's studies he mentioned among other matters that in 1902 Dr. Haldane published, in conjunction with Mr. J. Barcroft, an account of his new method of blood-gas analysis, based on a reaction which he had previously discovered. This method has since been extensively used in England as well as abroad, and out of it, directly or indirectly, has grown a long series of investigations with practical results. As the result of his observations it was shown that the cause of death in colliery explosions and fires is, apart from special cases of shock, mainly due to poisoning by carbon monoxide. The use of small warm-blooded animals as a practical test for carbon monoxide was first recommended by Dr. Haldane in 1906 and is now obligatory under the Coal Mines Act of 1911. They are similarly used in our submarines.

Directly connected with this line of research we have had the benefit of a very thorough series of tests, made on behalf of the Doncaster Coal Owners' Committee, of various types of apparatus for enabling men to penetrate irrespirable atmospheres. The provision of such apparatus had been made obligatory at mines, but had not hitherto proved of much service for rescue purposes, and several fatal accidents had occurred. The result of this special investigation was an elimination of some radically defective types, and a marked improvement in the self-contained rescue apparatus as well as in the training of the men using it.

Dr. Haldane's work on purely physiological problems has become of practical value mainly because of his ability and ingenuity also in closely related chemical problems. His apparatus for the estimation of minute percentages of methane is a model of simplicity, combined with accuracy and speed, enabling any intelligent amateur to make gas analyses of critical value to the colliery manager.

Those engaged in tunnelling and sinking operations are familiar with what is known as 'caisson disease,' which also affects the life conditions of deep-divers. Cases of unconsciousness following the rapid relief of pressure on emergence were found to be due to the disengagement of gas bubbles in the blood; and, for the purpose of investigating this subject, Dr. Haldane superintended the construction of a suitable steel chamber where experiments led to the discovery of a method of bringing men safely out of compressed air, without the loss of time due to the system recommended by Continental authorities. These experiments also led to various reforms of the other conditions observed during operations in which men were necessarily required to work in compressed air.

Turning from the class of cases in which the safety and health of the miner depends on chemical and physical variations in his atmospheric environment, Dr. Haldane's work has produced equally beneficial results in other ways. Among these, members will recall the photometric determinations made in conjunction with Dr. Llewellyn to show the marked effects of oxygen deficiency in air on the light given by a miner's lamp, a matter of special importance in connection with the influence of defective light in the production of the eye trouble known as 'miners' nystagmus.'

Another series of investigations dealt with the regulation of body temperature in warm and moist air, and these showed that in warm atmospheres, within wide limits, it is neither the temperature of the air nor the percentage of moisture present, nor the relative humidity, but the temperature shown by the wet-bulb thermometer which, other things (such as clothing, muscular exertion, and velocity of the air current) being equal, determines the ill effect of external heat on a man. For instance, if the wet-bulb temperature was at 89° F., it made no difference whether the actual temperature, as shown by the ordinary dry-bulb thermometer, was 89 or 130°.

"One of the most important and conclusive pieces of research undertaken by Dr. Haldane" — Sir Thomas remarked in continuation — " led to the discovery that miners' anæmia, which was prevalent especially in warm metal mines, was due to the tropical parasite *Ankylostoma*, and was therefore easily curable and controllable. This discovery was the result of his investigations, in conjunction with Messrs. J. S. Martin, R. Arthur Thomas, and Dr. A. E. Boycott in Cornish tin mines, and afterwards in Westphalia. Comparable in importance with the remarkable work on ankylostomiasis is that on the cause of miners' phthisis. To reduce the appalling death rate from this cause in the Transvaal alone would be a matter for pride, and the satisfaction of the metalliferous mining world was promptly expressed in 1904 by the Institution of Mining and Metallurgy, which conferred on Dr. Haldane one of its gold medals.

"The researches in connection with this subject paved the way for questions more familiar to members of this institution, namely, the possibility of additional dangers arising from the application of stone dust to prevent the occurrence and spread of colliery explosions. The result of this work, carried on as part of the work of the committee controlling the large scale of experiments inaugurated at Altofts, and subsequently continued at Eskmeals, will, I understand, shortly be issued. Here Dr. Haldane's work links up with that which we owe to the provision, energy, and public spirit of the distinguished first recipient of this medal.

"I have made no allusion to the more purely scientific and philosophical aspects of Dr. Haldane's work: if they had had no direct bearing whatever on the well-being of industrial workers, they would still be sufficient to mark him out as distinguished among his caste. I have also made no allusion to his public work as a member of various Royal Commissions and official committees of enquiry; they cover questions ranging from the ventilation of warships to the effects of the food and clothing of the soldier; and they deal effectually with noxious substances of varying types, from intestinal parasites to rats on board ships, and the latest product of German civilisation."

In conclusion Sir Thomas said: " Dr. Haldane seems to have been the friend of every man who, in the interests of industry or in the service of his country, undertakes what is known as a technically dangerous occupation. His untiring industry, his recognised ability, and his devotion to public duty are equalled only by the generous courtesy with which he is ever ready to assist his fellow worker, or to consider the views of a would-be critic. In inviting him to accept the highest mark of respect at our disposal, I am conscious that I am representing the wishes, not of our 3000 members only, but of the millions of working miners scattered throughout the world."

Dr. Haldane in replying, refused to recognize himself in the portrait Sir Thomas had drawn, and spoke of the pleasure scientific workers felt when their results proved immediately applicable in industry. He also gave an interesting account of the beginnings of his studies of the effect of CO_2 on breathing as an example of how the attempt to solve industrial problems lead to important scientific discoveries.

The papers read at the meeting were three in number. W. G. Fearnsides, professor of geology at the University of Sheffield, discussed at length the puzzling clay seams and 'wants' found in coal mines, holding them to be in the main incident to the process of consolidation of the coal. Sam Mavor, under the title 'Compressed Air for Coal Cutters,' gave much wholesome advice relative to avoiding losses in the use of compressed air, quite as applicable to rock drills as coal cutters. M. H. Mills discussed gas producers in a paper noted in our précis.

SAN FRANCISCO.

The Panama-Pacific Exposition is now at its brightest and best; perfect weather makes it an ideal resort for the visiting engineers who will come to the various congresses that convene here from September 16 to 25. The most important is the International Engineering Congress. This Congress consists of 3082 members, of whom 816 are from foreign countries. A total of 221 papers has been received, 158 from the United States. [The list is printed on another page—EDITOR.] The War has practically shut out the European delegates; hence the Congress will be chiefly American. The American Institute of Mining Engineers has a meeting at the same time.

From an Alaskan visitor we learn that the Kennecott mine is shipping 65% copper ore from the bonanza. Recent discoveries have caused an advance in the shares, which are now selling for $37 in New York. An unusual feature of these shares is that they have no par value, but represent merely a proportional interest in the mine. This absence of par value seems a feature worthy of imitation; especially by mines in the prospect stage. Similar financing is the issuing of debentures to equal the developed profit of a mine while the prospective profits are represented by common shares. Copper is said to be produced by the Kennecott mine for the extremely low price of 5 cents per pound. The previous record was of the Wolverine mine in Michigan—7. The disseminated copper deposits, notably the Utah Copper have also shown low costs. Lately the Chuquicamata took the palm with copper at less than 6 per pound.

Mining operations are on an increasingly large scale; the Perseverance mine and Alaska Gastineau mill will soon hold the record for output of gold ore; in June the mill was crushing 3300 tons daily; within a few months the normal tonnage of 12,000 will be reached. The Treadwell mills treat about 5000 tons daily. Among other large producers of gold ores is the Homestake mine of South Dakota, which treats 4500 tons per day in its various mills. The porphyry copper mines also handle a large tonnage; the Chino company is concentrating 8000 tons daily. The 'Copper Country' of Michigan likewise yields much ore; in July, 13 mines shipped 500,000 tons. The largest output for copper mines is probably the Utah Copper company with an average of over 20,000 tons of ore daily, and a maximum production of 30,000 tons.

The sampling of a mine used to be a simple business, but nowadays the expense runs into the scores of thousands of dollars. A recent example is the sampling of the Georgia Slide mine in Eldorado county, California, a belt of slate that has been worked in a small way for 50 years. The deposit is now being studied by New York capitalists, who propose to sample it by erecting a 300-ton mill. This is probably the maximum size of mill built for sampling a single mine.

Antimony mines are active. A new mine has been developed in the Ballarat district, San Bernardino county; the ore is sent on motor-trucks to the smelter at San Pedro, the port of Los Angeles. The Chapman smelter in San Francisco is running twenty small furnaces on ore from British Columbia, Alaska, and Nevada.

In spite of the decline in the price of silver the Tonopah mines are all operating with full force; and prospecting in the outlying claims is being pushed. A curious feature of the silver market is that the Selby smelter has, in a number of instances, paid $\frac{1}{4}$ cent to $\frac{1}{2}$ cent more than the market quotation. Oatman, in Arizona, is growing in population and new mines are being opened. The Gold Roads and Tom Reed mines are the most important of the older properties. The Oatman shares have just been listed on the San Francisco Stock Exchange.

The Mexican situation shows no change, except that the troubles along the frontier in Texas are becoming more acute and Mexican bandits have made attacks on United States regulars. In retaliation, the Americans have killed a good many Mexicans, but this side of the story is not emphasized.

Flotation is now being largely employed in the southeast Missouri lead region, in treating the slime or classifier-overflow. Seven mills crushing from 2000 to 4500 tons per day are using the process, which has been introduced in accordance with the method used in the Federal mill in Idaho. The mines of the Big and Little Cottonwood districts of Utah are now attracting much attention; shares have advanced from 6 cents to $5 in one of the mines, and a mild boom is in progress. Lead, silver, and copper are the chief metals.

TORONTO.

PORCUPINE.—The output of gold from the Porcupine district is steadily increasing. The report of the Ontario Bureau of Mines for the six months ended June 30 gives the value of the gold production of Ontario at $3,570,072, as compared with $2,011,069 for the corresponding half of 1914, nearly all of which came from Porcupine. The regular 4-weekly statement of the Hollinger for the period ended August 12 showed gross profits of $147,288, from the treatment of 28,358 tons of ore of the average assay-value of $9·03 per ton, the working costs per ton being $3·28. A vein discovered by diamond-drilling was encountered in sinking the main shaft, which is now some distance below the 950-ft. level. It is between 9 and 10 ft. in width and carries ore running $8 to the ton, and has been cut by the diamond drill at points 1000 ft. apart. Adjustments are being made to the mill which will increase its capacity by 20%. The Dome statement for August shows 28,600 tons milled of the average assay-value of $4·68 per ton, with a gold production of the value of $133,928. The level at 700 ft. is being developed with good results. The present shaft being entirely in ore, a new shaft will be sunk on an incline, up which all the ore from the mine will be hoisted, after being crushed to 6 in. underground. The McIntyre, in driving at the 500-ft. level, has run into a body of ore 6 ft. in width, which is officially stated to assay $30 to the ton. At the Rand Syndicate claims a series of test pits are being sunk to decide the best place for putting down a shaft. The Dominion Reduction Co. has dropped its option on the Hollinger Reserve which it had been sampling for some time. The same company has taken an option on the eight Bowser claims and the two Brennan claims, in all 400 acres in the Goodfish Lake area.

KIRKLAND LAKE.— Interests associated with the Buffalo mine of Cobalt have secured a controlling interest in the Teck-Hughes by the purchase of two-thirds of the issued stock, and a change in the management has been effected, C. L. Denison, of Buffalo, becoming president and general manager, and R. W. Pomeroy, of Buffalo, vice-president. A bond issue of $150,000 will be made, which will furnish working capital. A mill of 100 tons capacity is being erected, and it is also proposed to install a new power plant. The Tough Oakes mine has been closed down owing to a shortage of electric power. A steam plant is now being installed. A winze has been put down from the 300 to 400 ft. level in rich ore, the vein 5 ft. in width averaging $70 to the ton.

COBALT.—The diminution in the output of silver continues, the fall being largely due to the low price of the metal. The Ontario Bureau of Mines gives the value of the output for the first six months of 1915 at $5,188,763, as compared with $7,053,418 for the corresponding period last year. The Nipissing during August mined ore of an estimated value of $179,048 and shipped bullion from its own and custom ore valued at $118,047. The company has entered into an arrangement with the O'Brien to co-operate in development work in adjoining territory. A rich orebody has been found by the Cobalt Lake Co. at the southern end of the lake near the Nipissing line and dipping toward the Nipissing property. The Shamrock has been unwatered, and cross-cutting commenced on the 400ft. level. At the Beaver the main shaft is down to 1100 ft., and will be sunk farther until the lower contact between the diabase and Keewatin formations is reached. A promising orebody has been encountered on the 300 ft. level. A Toronto-Haileybury syndicate has taken an option on the Bellellen mine in the South Lorrain district.

DOBIE MINE.—From the Dobie gold mine in Munro Township, some 50 miles to the East of Porcupine, operated by the Dominion Reduction Co., a shipment of gold of the approximate value of $50,000 was recently made. It was the product of 750 lb. of ore, hand-picked from a very rich pocket in the shaft. It is estimated that the tailing contains an additional $30,000. As the land in the vicinity of this mine has nearly all been staked some time since, the Dobie discovery created comparatively little excitement as compared with the Kowkash rush.

JOHANNESBURG.

AMERICANS ON THE RAND.—One prominent feature of recent mine management on the Rand is the tendency to dispense with the services of American mine managers and consulting engineers. Why this should be so is not altogether easy of explanation. Twenty years ago, and even before that date, the Rand mining industry was virtually being established by American engineers, the mines of all the leading groups being under American control. With the departure of the consulting engineer of the Goerz group at the end of this year, nearly all the American engineers and managers, with the exception of those left on the Crown Mines, will have disappeared. Of American managers still with us may be mentioned Palmer Carter of the Robinson, Paul Selby of the Ferreira Deep, and L. A. Womble of the Geduld.

It might be expected that after the marked success which has attended the employment of American engineers and metallurgists on the Rand, surely others might be found capable and willing to take the place of the early pioneers, even if salaries have in the meantime fallen to more modest and reasonable proportions. It is well known that the study of practical gold mining methods in England is impossible where metalliferous mining is overshadowed by coal mining, and on reflection it seems difficult to explain why American mining and metallurgical talent is becoming so rare on the Rand seeing that Americans possess many facilities for acquiring that practical knowledge and training so suited to Rand requirements.

If there is a present-day tendency on the Rand to employ other than American mining engineers and mine managers, it does not arise from the past records showing that they have been a failure. Such names as John Hays Hammond, Hennen Jennings, Harry H. Webb, Frederick Hellmann, Thomas H. Leggett, W. L. Honnold, and George E. Webber will long be remembered for what they have done for practical mining on the Rand, while in the metallurgical world the Rand has also much to be grateful for to American talent, the names of Charles Butters and F. L. Bosqui immediately arising in the mind in this connection.

Of late years mining engineers and managers versed in coal mining methods have found more employment on the Rand gold mines. Their first introduction was due to the ventilation difficulties increasing with the depth and the fact that they were more versed in the details of ventilation than those brought up to metalliferous mining. Several mines had reached a depth at which the application of artificial ventilation became indispensable, while miners' phthisis had become such a reality that everything tending toward its eradication had perforce to be introduced. Then as depths increase and dips decrease the methods of mining are sure to more closely approach those of coal mining, so that coal mining methods may come more into vogue on the Rand.

EARTH TREMORS.—The Earth Tremors Commission has continued to take evidence regarding the origin of tremors. The evidence has been interesting if somewhat contradictory. The majority of the witnesses agree that these tremors are due to mining operations, but not one when questioned could indicate how it would be possible to prevent them.

Mr. Kenneth Austin attributed the tremors to bad mining. More attention, he said, ought to be given to systematic packing, whilst filling by dry sand ought to be more generally adopted. The present extent of sandfilling he denounced as only piece-meal work. Many engineers will agree with Mr. Austin in these remarks, but few will regard his suggestion of continuous safety pillars 150 ft. apart as calculated to prevent these tremors, unless at comparatively shallow depths from the surface.

Messrs. Edgar Pam, Percy Cazalet, and Stuart Martin also gave evidence, and their opinions showed wide variations. The gist of the evidence leads to the conclusion that these tremors were caused by subsidence transmitting a vibration beyond the outcrop in a northerly direction upon which the town of Johannesburg is built. In Johannesburg itself the tremors are exactly similar in all respects to miniature earthquakes, but they rapidly die out in all directions. The hanging wall in the mines is quartzite, and consequently does not bend to any extent on subsiding, but probably snaps asunder, thus giving rise to tremors. Pillars left in the mines probably tend to decrease the tremors, but it is evident that if the lode was exhausted at one operation, and promptly stowed solid with sand, the tremors would rarely occur. Mr. Kenneth Austin's proposal to leave continuous pillars would only answer at comparatively shallow depths unless increased with depth, and would therefore soon become impracticable. If pillars are compulsory they must be large, not small ones as suggested by Mr. Stuart Martin; in fact so large that any movement of the hanging wall would be impossible. It is clear that a depth will soon be reached on the Rand when even large pillars will prove inadequate to bear the strain. As driving through the solid and extracting the reef when retreating is impracticable, the only method of reducing these tremors to a minimum seems to be the adoption of a modified system of longwall working, accompanied by sandfilling to such an extent that no cavities are left. There are many difficulties and drawbacks to overcome if true longwall methods are adopted, particularly with regard to unprofitable areas, because any unworked areas would be just as likely to cause uneven settlement.

PERSONAL.

A. H. ACKERMANN and S. C. DYER arrived from Rhodesia on September 16, to give expert evidence in the Amalgamated Properties versus the Globe & Phœnix.

R. A. BARRY has been appointed manager of the mines of the Transvaal Gold Mining Estates.

B. V. BARTON has gone from New South Wales to Korea.

E. W. BYRDE, of the Royal Engineers, has been awarded the Military Cross for gallant work in pushing mines into the enemy's ground.

W. H. CLARK has left for India.

H. O. CRIGHTON is expected from Nigeria.

G. A. DENNY has gone to South Africa.

FRANCIS DRAKE has returned from Rhodesia.

W. R. FELDTMANN has left for West Africa.

DONALD A. FOSTER has returned from Venezuela.

B. L. GARD'NER has received a commission with the 171st Company of the Royal Engineers and is now in France.

PHILIP GRIMLEY is returning from Nigeria.

THEODORE HADDON, manager of the Globe & Phœnix, is here.

G. A. HARRISON, lieutenant in the South Wales Borderers (Pioneers), has been transferred to the 173rd (Tunnelling) Company, Royal Engineers, and is with the British Expeditionary Force in France.

W. T. HOLBERTON has left for Chile.

E. C. HOMERSHAM has left for the Randfontein Estates, South Africa.

PERCY HOPKINS, of the Ontario Bureau of Mines, is examining the gold ore deposits recently discovered at Kowkash.

R. S. INNES leaves at the end of October for the Belgian Congo.

H. EWER JONES has returned from Rhodesia.

A. MCARTHUR JOHNSTON left on his return to Johannesburg on October 9.

W. P. JOSHUA has left for India.

A. G. KIRBY is manager for the Dominion Gold Mines Ld., the company organized to work the Dobie claims in Munro township, Ontario.

J. KOBUSE has been examining mines in Korea.

A. F. KUEHN has returned from his inspection of the Messina mine.

W. J. LAKELAND is here from Burma.

R. B. LAMB has moved his office from Toronto to Room 1615, 27 Cedar Street, New York.

J. G. LAWN is the Government representative at the Oldbury explosive works, Birmingham.

G. MACFARLANE is returning from Mawchi, Burma.

GEORGE V. MICHELL has gone to Russia.

KENNETH A. MICKLE has resigned from the metallurgical staff of the Burma Corporation and received a commission in the Royal Garrison Artillery.

ROBERT RAINE has retired from the management of the Village Main Reef.

FRANK REED, Inspecting Engineer of Mines, New Zealand, has received the additional appointment of Chief Inspector of Coal Mines.

ALEXANDER RICHARDSON is on the engineering staff of the Government high-explosive factory at Queen's Ferry, near Chester.

FRANK ROWLEY expects to return to Tasmania shortly.

H. R. RUGGLES-BRISE is here from South Africa, and has received a commission with the Royal Engineers.

A. J. SMITH, for many years in charge of the Broken Hill South office, has been appointed London secretary to the Broken Hill Associated Smelters company.

E. A. CAPPELEN SMITH has returned to New York from Chuquicamata, Chile, having set the great leaching plant going successfully.

J. ERNEST SNELUS sailed for Nigeria on September 22.

NORMAN C. STINES, manager of the Sissert mine, is expected in London.

J. H. STOVEL is in charge of development operations at the Bruce mine, Ontario, belonging to the Mond Nickel Company.

WILLIAM THOMAS has left for the Champion Reef mine, India.

J. LEWIS WALTON is expected back from West Africa.

STUART S. WEBB-BOWEN is returning to London from Nigeria.

A. R. WHITMAN is making a geological study of properties north of Cobalt lake, Ontario.

GEORGE WILLIAMS, for some time superintendent of the Greenwood smelter of the British Columbia Copper Co., is now with the Anaconda Company at the Washoe smelter.

CHARLES WILL WRIGHT has returned to Sardinia after his visit to the United States.

WILLIAM WHYTE is returning to the Messina mine in the Transvaal on October 30.

PRECIS OF TECHNOLOGY

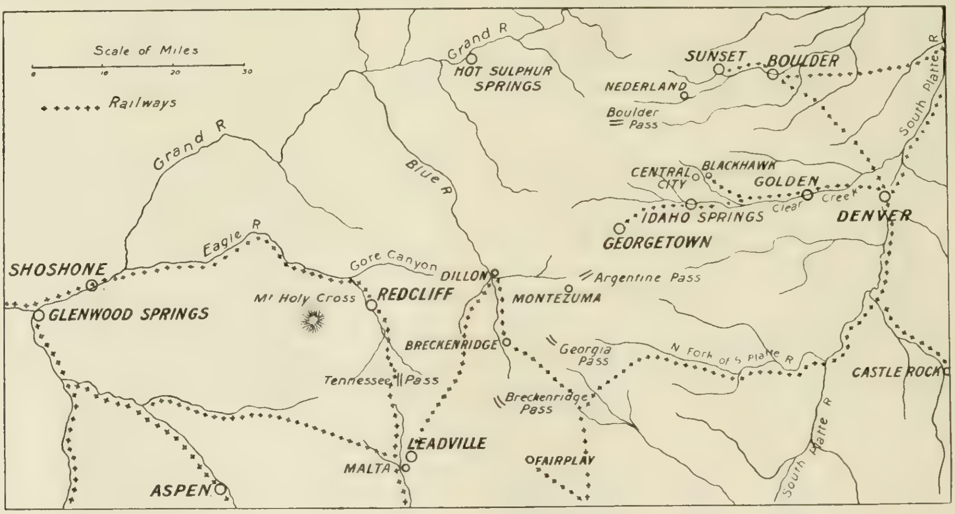
[Copies of the original papers and articles mentioned under this heading can be obtained on application to the Technical Bookshop, Salisbury House, London, E.C., the book department of The Mining Magazine.]

Studies of Mine Dust.—The August issue of the *Journal* of the Chemical, Metallurgical, and Mining Society of South Africa contains a paper by Dr. James Moir entitled 'Recent Investigations on Dust in Mine Air and the Causation of Miners' Phthisis,' dealing chiefly with the size and number of the particles composing the dust. In the first section of his paper he calculates the rate of settlement of the particles, and by Stokes' formula finds that a particle with a diameter of 1 micron (μ), that is to say one-thousandth of a millimetre, takes 5½ hours to fall a distance of 5 ft., and a particle of 10 microns diameter a period of 3½ minutes. It is clear that the smaller-size particle will not settle at all in the eddying and circulating air of a mine. In the second section, he calculates the size and weight of quartz particles. He assumes that the particles are in shape like rounded tetrahedra, and taking d as the distance from the most prominent point of the particle to the middle of the opposite side, assumes the volume as somewhere between $0{\cdot}3d^3$ and $d^3/3$. Taking the specific gravity of quartz at 2·65, it is found that 1,200,000 particles of 10 microns diameter weigh 1 milligram, and of course the number of those of 1 micron diameter would be a thousand times as great. He estimates that the average diameter of the floating particles is 3 or 4 microns. The Rand ore contains also aluminous material such as sericite and chlorite, and rutile and anatase, and these are less easily wetted than quartz, so that the average floating dust contains a higher percentage of them than the average ore. The small size of the dust particles explains why respirators are of little use. No respirator has apertures as small as 10 microns, and in one that enjoys considerable vogue the apertures are 250 microns in diameter. The finest metal screening, 260-mesh, has apertures of 50 microns.

Dr. Moir proceeds to investigate the rate of settlement of quartz particles in water. Using Stokes' formula again, he finds that a 10 micron particle falls at the rate of 0·007 centimetres per second, a 20 micron particle at 0·028 cm. per second, and a 60 micron particle at 0·25c cm. per second. The latter two figures agree with the observations made by H. Stadler, but the rate for 10 micron particles is less than Mr. Stadler's figure, 0·01 cm. per second. Possibly Mr. Stadler's higher rate for settling was due to a predominant proportion of pyrite in the finest slime. This varying speed of settlement for particles of different sizes is used in classifying the particles and separating the finest from the coarser, but instead of water, a sugar solution having a viscosity double that of water is employed. By this means the particles of 12 microns or less remain floating and the larger particles sink. In examining the lungs of the victims of miners' phthisis it has been found that the diameter of quartz particles that lodged permanently in or on the tissues averaged less than 3 microns, that very few were above 8 or 10 microns, and that none were greater than 12 microns. Anything larger than 12 microns can therefore be removed by the lungs, so in investigating the number of nocuous particles per volume of air it is necessary to separate the larger particles and count only those below 12 microns. Dr. Moir has taken a great many samples of mine air under different conditions, and has counted and classified the dangerous particles. His highest figures were obtained after blasting, when nearly 90,000 particles were found in 1 cubic centimetre of air. During dry-drilling the number was 9500. With wet holes the number was 80 to 330, and with a promiscuous spray 400 to 2200. On the surface, near dumps, the number was from 25 to 100, and in modern crusher houses 50 to 500. In all these cases the air contained large as well as the dangerous small particles, and by separation in sugar solution it was found that the particles in mine air under all conditions were mostly of the dangerous small size, the percentage by number being over 98% and by total weight from 60 to 90%. With surface air in the street or near dumps the percentage by number is 50 to 90, and by total weight from 1 to 60. In crusher houses the proportion of dangerous particles is higher. Thus it is clear that the danger from dust is far greater in mines than above ground. If we take 7000 cubic centimetres as the amount of air breathed per minute during light work, it is seen that at least a million objectionable particles enter the lungs during that time. The number would be 60 million during dry drilling or after blasting. If the man is working hard he will inhale at treble this rate. It is notable also that Dr. J. S. Haldane gives figures for breathing during light work at four times those of Dr. Moir. Mr. Moir's paper and his tables of results are of classic importance and should form the basis of much discussion.

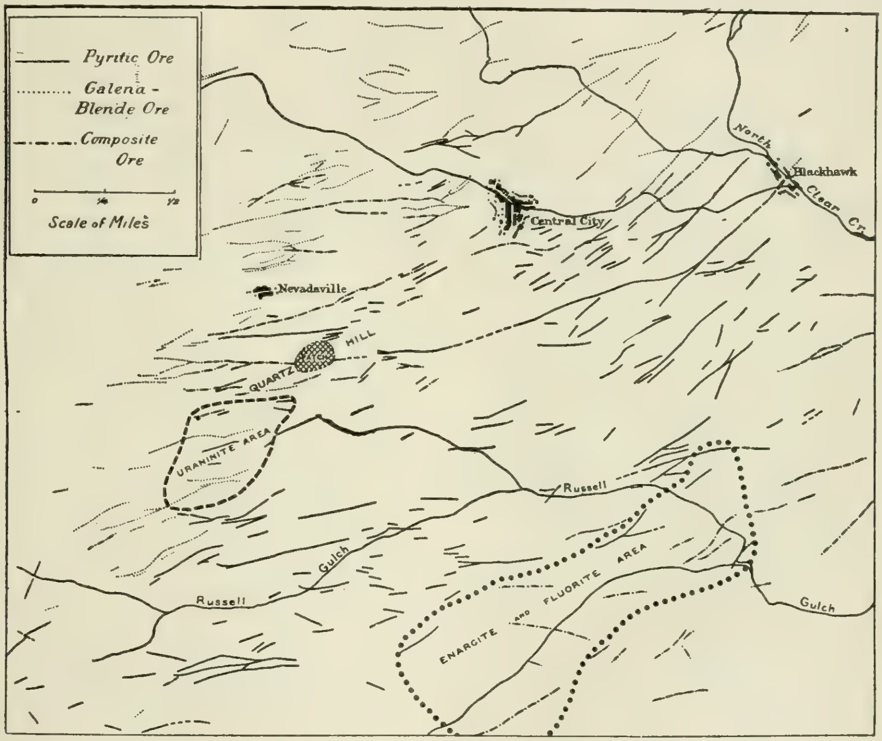
Origin of Rand Gold. — In a paper read at the meeting of the South African Association for the Advancement of Science, E. H. L. Schwarz discussed some recent evidence in connection with the origin of gold in the Rand banket. Mr. Schwarz is an Associate of the Royal College of Science, South Kensington, and is now professor of geology in the Rhodes University College, Grahamstown. In his paper he reviews briefly the three theories, namely, the placer, subaqueous deposition, and infiltration. He holds that the placer theory affords the most reasonable explanation. The gold was deposited in the usual erratic manner characteristic of placers, with rich nuggety patches, but when the beds sank and were covered with subsequent deposits 30,000 ft. thick, they were subjected to so great a heat and pressure, that the gold was dissolved in water contained in the beds. In this way the gold was changed in form and the large pieces reduced. Thus the present condition of more equal distribution of fine gold was attained. Mr. Schwarz proceeds to combat the argument in favour of infiltration based on the petrographic sequence of certain minerals of the banket adduced by Hatch & Corstorphine, and by R. B. Young. These writers have shown that there are several generations of minerals in the matrix of the pebbles. For instance gold is found attached or moulded on pyrite, and pyrite is found surrounding tourmaline crystals, which in turn are moulded on quartz grains. These facts go to show, according to these writers, that there have been a series of percolating solutions coming from outside which have passed through the pebble beds before the interstices were closed. Mr. Schwarz is not convinced that such a thing is possible at the great depths at which the circulations are presumed to have taken place, for he considers that such solutions would under those circumstances be just as likely to have passed through the interstices in the sandstones immediately adjacent, and he cites the well known fact that the gold is confined to the pebble beds. He also argues that under these great pressures all minerals are pervious to such solutions, and therefore that the pebbles themselves would be found to contain gold and secondary minerals, in the same way as the beresite of Siberia (described in our issue of February 1914). As secondary minerals are not found in the pebbles, he is of opinion that the infiltration theory is not helped. Mr. Schwarz proceeds to give his reasons for believing that these secondary minerals were deposited during a period of metamorphism, and that they were obtained from sources within the banket, not introduced from outside. We have not the space to quote his argument in full, and refer readers to the original paper, contenting ourselves with this statement of his opinion. His paper is printed in the *South African Mining Journal* for July 17 and 24, and August 7.

Gilpin County, Colorado.—The gold ores of Gilpin county have been of interest to the miner and metallurgist ever since the rush took place in 1859, a rush second only to that to California ten years previously. In the early days placers and oxidized ores were chiefly worked, and later the complex auriferous and argentiferous sulphides have been mined, the treatment being by amalgamation and subsequent concentration, the concentrates being sold to smelters. The mineral district is not entirely within the confines of Gilpin county, but is partly included also in Clear Creek county to the south and Boulder county to the north. The principal mining centres are Central City, Blackhawk, and Nevadaville in Gilpin county, Idaho Springs in Clear Creek county, and Caribou in Boulder county. The region is in the heart of the Front Range of the Rocky Mountains and lies 30 to 35 miles west and northwest of Denver. An exhaustive report on the economic geology of the region has been made for the United States Geological Survey by Edson S. Bastin and James M. Hill, and Mr. Bastin has written an article on the ores of the district for *Economic Geology* for May of this year. We extract a few notes from this article. The rocks are of Pre-Cambrian age, consisting of mica schist, granite-gneiss, quartz diorite, and granite. Through these Pre-Cambrian rocks have been intruded many stocks and dikes, believed to be of Tertiary age, the principal rock-type of their composition being monzonite porphyry. As regards structure, the chief characteristic is the intricate manner in which the igneous rocks from Pre-Cambrian to Tertiary age have been intruded into the schist groundmass and into each other. The auriferous orebodies are usually veins and sometimes stockworks, and have been deposited along lines of minor faulting that took place before or contemporaneously with the intrusion of the Tertiary igneous rocks. But probably a larger proportion of the ore was formed as a replacement of wall-rock. As a rule the stockworks are of less importance than the veins proper, but one notable exception is worthy of mention. This is the so-called 'patch' on Quartz Hill, which is a sort of pipe of brecciated quartz 500 by 800 ft. in cross-section. This patch was formed by a great number of strong vein-fractures approaching each other closely. These veins are proved to leave the patch at the two ends, the distance between each gradually increasing. Other deposits in the region, such as those of titaniferous iron ore, have been apparently magmatic segregations. Though the region is primarily noted for its gold, silver is also fairly abundant. The sulphide minerals are not usually of great economic importance, but copper and lead, and occasionally zinc, have added to the value of the concentrates. The titaniferous iron ore already mentioned is not commercially valuable. In Boulder county there occur deposits of tungsten ore, chiefly ferberite, that is to say, pure tungstate of iron; these deposits are the largest producers of tungsten in the United States. South of Nevadaville, near Quartz Hill, pitchblende is found, associated with sulphide minerals; it is widely distributed, but not seemingly in sufficient quantity to be of large commercial importance. We described the pitchblende occurrence in our issue of September 1914.



MAP OF PART OF COLORADO, TO ILLUSTRATE ARTICLE ON GILPIN COUNTY.

The gold-bearing veins always contain silver. In most cases the gold greatly predominates, the exception being when there has been a downward enrichment of the silver. Usually the precious metals are associated with the various sulphides, but an important amount also occurs in the form of tellurides. The auriferous sulphide ores may be classified into three groups, the first consisting of pyritic minerals, the second of galena-blende minerals, and the third of the minerals of both the first and second groups. The first is the most important. Pyrite is the chief sulphide, with chalcopyrite and tennantite in subordinate quantities. In some places enargite appears instead of tennantite (both of these being sulpharsenides of copper), and in these cases fluorspar accompanies. The pyritic ores are usually irregularly massive. The constituent minerals were all deposited during the same period of mineralization, but there is recognizable among them a prevailing sequence of crystallization. Chalcopyrite, tennantite, and fluorspar were deposited in greater abundance in the later than in the earlier stages of the pyritic mineralization, as shown by their tendency to line vugs and to occupy the middle portions of veins. The gold content is usually greatest when the proportion of chalcopyrite ides, Mr. Bastin has not been able to obtain evidence as to their relationship with the sulphides. Mr. Bastin proceeds to discuss downward enrichment, and finds that gold, silver, and copper have been affected by this process. Gold was largely mechanically concentrated by the weathering of the sulphides, but was also partly dissolved in the waters in the upper oxidized portions of the veins, to be quickly re-deposited in the lower parts of the oxidized veins by ferrous sulphate or by the sulphides. In any case, if the gold solution was not precipitated then, it soon would be on passing below the water level. Thus it is found that gold enrichment has taken place in the lower portions of the oxidized veins, but hardly at all in the



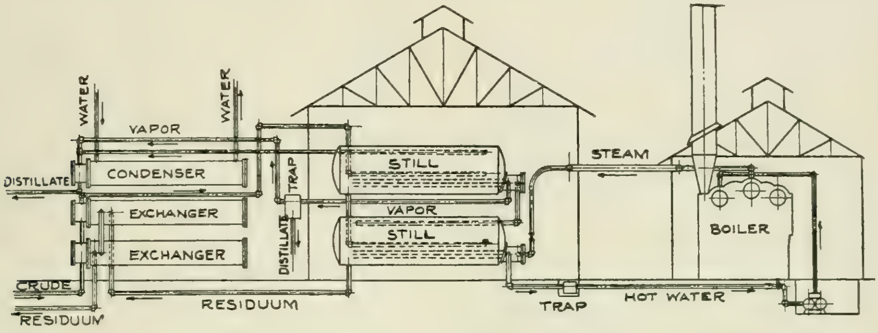
THE VEIN SYSTEMS OF GILPIN COUNTY, COLORADO.

present is highest. The second group, with galena and blende as predominant sulphides, contains pyrite and chalcopyrite in subordinate amounts, but no arsenic minerals. The sulphides are associated with quartz and either siderite or calcite, and barite and rhodochrosite are also found. As regards the genesis of the ore, most of the constituents appear to be contemporaneous, though the formation of 'rosin' blende, calcite, siderite, and quartz continued later than that of the others. The precious-metal content is more variable than in the case of the pyritic ores, and in some cases, as at Caribou, the amount of gold is negligible, and the ores can then be worked only when the silver has been augmented by downward enrichment. In the third group, where all the sulphides occur together, it is found that the pyritic mineralization has occurred first, and that the galena-blende minerals have been subsequently deposited along lines of fracture that were formed between the two epochs of mineralization. As regards the tellur- sulphide zone below. With silver the conditions are reversed, for there is impoverishment in the oxidized zone and enrichment in the sulphide zone. The silver enrichment is almost entirely confined to the galena-blende group of ores. The study of the deposition of secondary silver minerals is described in some detail by Mr. Bastin. The author proceeds to discuss in detail the method of formation of the primary ores of the region, attributing them to thermal solutions that escaped from the 'porphyry' magmas, probably during their crystallization. The composition of these solutions may be inferred from the mineralogy of the ores and the wall-rock alterations. They were alkaline or neutral and were rich in alkaline earths. During the early stages of mineralization they were rich in iron and silica, and during the later stages rich in lead, zinc, carbonate, and bicarbonate; they carried less amounts of copper, arsenic, antimony, gold, and silver. Locally they carried manganese, sulphate, barium, tellurium, fluorine, uranium, and vanadium.

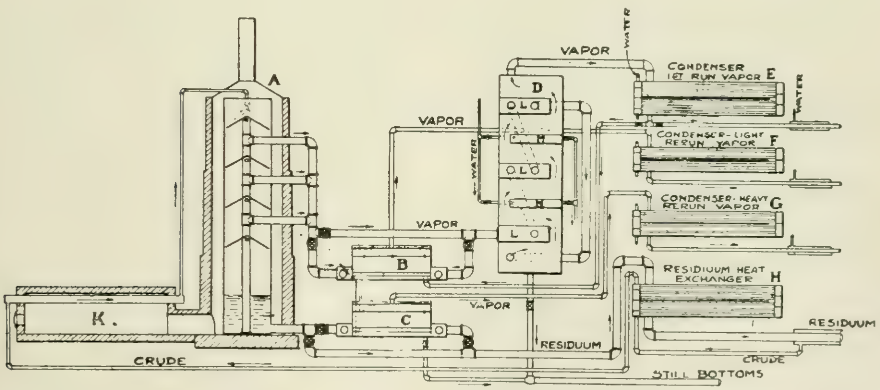
Gas Producers at Collieries.—Among the papers presented at the Leeds meeting of the Institution of Mining Engineers held in September, was one by M. H. Mills which should be read by all interested in economical power production whether at collieries or elsewhere. After reviewing briefly the history of the introduction of gas producers and gas engines, and stating the systems upon which gas producers were built, Mr. Mills described in detail the work of ten plants employing various types of producers in England. The primary object of the producer is to obtain the maximum amount of combustible gas, which is accomplished by delivering CO in place of CO_2, decomposing meanwhile the moisture present or added as steam into hydrogen and oxygen. These gases, mixed with the volatile matter in the fuel, are delivered for burning under boilers or for direct use in gas engines. The advantage of the practice is that it permits the use of low-grade fuel much of which would otherwise be wasted. Producers are built either with or without auxiliary plant for the recovery of by-products. The former are simpler and show lower first cost, but the absence of by-product saving increases the operating charge. Both down-draught and up-draught producers are available, and at the Smith & Faires works at Leicester is a Dowson & Mason plant which is 'double acting,' air being drawn in at both top and bottom. The down-draught producers, as shown in the article by Mr. Degenhardt on another page, operate so as to break up the tarry products in the producer and so do not necessitate scrubbers and auxiliary plant. Up-draught producers, however, whether suction or pressure, may be run with only a simple sawdust filter and without elaborate arrangements for cleaning the gas. Mond gas producers are used at a number of collieries, brickworks, and other plants, and are furnished both with and without by-product recovery plant. At the Brodsworth colliery there are two producers burning 'slack' containing up to 30% ash. The gas is filtered and used in engines direct without trouble. At the Langwith colliery there are 8 producers which work 24 hours per day without trouble. The analysis of the fuel shows: Ash, 10 to 12%, volatile, 28 to 30%, nitrogen, 1·3 to 1·4%. About 62 cu. ft. of gas is obtained per lb. of fuel, with about 80 lb. of sulphate of ammonia and 4 gallons of pitch per ton of coal. At the Denaby main colliery, Mond producers furnish 70,000 cu. ft. of gas per hour for engine use. The Kerpely producer, used at the Shelton Iron and Steel Works and at the Lumb glass works, employs a water-jacket to permit easy use of clinkering or caking fuel. It is also built with a revolving grate. Using a coal containing 21% ash, a 10 ft. producer gasifies about one ton per hour, the feeding being at intervals of 20 minutes, and poking every half hour. About 150,000 cu. ft. of gas is obtained per ton of coal. Wilson producers are used at the Littleton plant. They are of simple type without elaborate cleaning apparatus, a Root blower for the air and steam blast being the only mechanically driven part. The cost of such plant complete except for excavation and builder's work is given as about £2. 10s. per brake-horse-power. The Dowson-Mason producer has already been mentioned. In units from 25 to 100 hp. on bituminous coal it can be worked by suction from the engine alone, but with large units a blower is necessary. For burning a non-clinkering coal it is a simple and economical type. Kynoch producers are widely known and used. They are of the down-draught type, and are giving satisfaction in many applications. Duff by-product plants are used at Glasgow and Sheffield in large complex units that are described in detail. In conclusion Mr. Mills points out that while "the country cannot expect the coal-owner to increase the cost of getting the merchantable fuel in order to use up a low-grade fuel now lost," it has a right to ask that the rapidly diminishing supply be not wasted and that the use of gas producers will permit the opening of beds of coal unsaleable at the present time.

Oil Refining in California.—Until the year 1908 the petroleum produced in California was heavy oil suitable for burning as fuel for steam-raising purposes. In that year the Santa Maria and Midway oilfields were developed, and the petroleum obtained there contained a large proportion of light oils, together with much water held in a state of emulsification. It became necessary to remove the low-flash components in order to make the petroleum acceptable for steam-raising purposes, and at the same time it was desirable to save the low-flash oils owing to the growing demand for them under the names of gasoline and petrol. As the production of a safe fuel-oil was the chief desideratum, it was considered that refining in the ordinary still was not necessary, but that a cheaper and more rapid method would serve the purpose. This is locally called 'topping,' that is to say, removing the lighter or 'top' oils. A number of processes were introduced, all based on continuity of action. An account of the various plants is given by Arthur F. L. Bell, engineer to the Associated Oil Co., in a paper published in the September *Bulletin* of the American Institute of Mining Engineers, from which we make the following extracts. One of the earliest of the processes was that erected at Avila in the Santa Maria district according to the designs of E. I. Dyer, engineer to the Union Oil Co. According to this design, the crude oil is sent through stills and heated by means of steam coils. The accompanying illustration gives an outline of the Avila plant. The crude oil is first passed through 'exchangers' where it is heated by the hot oil coming from the 'topping' stills, and is then pumped first to the second or upper set of horizontal stills, passing afterward to the first or lower set of stills. In the first or lower set of stills the oil is heated to a high temperature by high-pressure steam, which is passed through coils of pipe. The vapour composed of the lighter oils and steam arising from the crude oil is conducted to the coils in the upper or second series of stills where it heats the oil and removes some of the lighter oils and the water. The vapours from both sets of stills are sent to condensers, and the residual oil is passed as already stated through the 'exchangers' to the storage tanks. The temperatures of the two sets of stills and of the steam and the vapours are arranged carefully so that the minimum amount of heat is required. Records of specific trials with this oil show that of the crude oil treated about two-thirds is recovered as heavy oil, and 13% as petrol, while about 16% consists of water.

At other oilfields, different methods of treating the oil on the continuous system are used, based on heating the oil as it passes through the tubes or tubular retorts by means of the exterior combustion of crude oil. One of these systems, known as the Trumbull method, has been largely adopted recently, and the patents have been acquired by the Shell Company, which is erecting a big works at Martinez. The crude oil is pumped through pipes contained in a furnace heated by oil, instead of being treated internally by steam in coils. The accompanying illustration shows the system diagrammatically. The crude oil enters first the three vapour condensers E and U, then passes forward and backward four times through the tubes of the 'exchanger,' then to the residuum heat exchangers H, then to the top of the evaporator column T. The crude oil on entering the column T is diverted to the heated side in its downward course by the conical deflectors and finally drops into the base of the column. From there it passes through the retort K, then up to the top of the evaporator A, where in its downward course it is deflected against the shell heated by the furnace gases. The first vapours to come off are from the hot crude oil in the evaporator column T. These are led to the separator B, then to changer. The vapours from separator S pass to the condenser V in the same manner as those from B and C; they are heavier than those from the other two separators. The unevaporated distillate from separator S is not further refined and is run to storage. Each of the three separators has two separate vapour chambers, each having a separate outlet connected to its independent condenser, so that the three separators will give six different grades of varying gravity of re-run products. An additional product will be the still bottoms drawn off from the separator S.



THE DYER SYSTEM FOR 'TOPPING' HEAVY OIL.



THE TRUMBULL SYSTEM FOR 'TOPPING' HEAVY OIL.

the condenser E, where the distillates are condensed and returned to the lower compartment of the separator. The vapours on leaving separator B, which are of the lightest gravity, are condensed in F, and then pass off through jacketed pipe coolers to storage, while the unevaporated distillates from separator B pass to separator C. The second vapours coming off from evaporator A are collected in the central perforated pipe, and are led to the jacket of the evaporator column T. After imparting a certain amount of heat to the inner shell, they pass through the heating tubes in separator C, then to condenser U, the condensed distillates being returned to the lower compartment of separator C to be evaporated, as previously described. The vapours then flow to the condenser G. These distillates are of a heavier grade than those from separator B. The unevaporated distillates flow from separator C to separator S, which is heated by the hot residuum passing through it on its way to the ex-

Zinc in Canada.—In our last issue, our Toronto correspondent mentioned that the Canadian Government intended to offer a bounty on zinc produced within the Dominion. In this connection an article on 'Zinc in Canada' by Alfred Stansfield appearing in the September *Bulletin* of the Canadian Mining Institute will be of interest. Dr. Stansfield is the professor of metallurgy in the McGill University, Montreal.

The urgent need of zinc for the manufacture of war munitions has led to the production of spelter in Canada from Canadian ores. A Commission, consisting of Col. D. Carnegie, Dr. A. W. G. Wilson, and Dr. Stansfield, was appointed some months ago by Major-General Samuel Hughes, the Minister of Militia and Defence, who early in the war saw the necessity of obtaining Canadian zinc for munitions. This Commission has been studying the supplies of Canadian ores, and the means available for turning them into spelter, suitable for the manufacture of ammunition. As a result of this work, and of the enterprise of Canadian metallurgists, spelter will now be produced in Canada, suitable in quality and quantity to meet the local needs of the British War Office and the Canadian Shell Committee. A number of years have elapsed since the value of the Canadian zinc ores was recognized, but until the present time there has been no commercial production of spelter in the Dominion. Zinc, which is mostly found in British Columbia, is associated with lead, and owing to its harmful effect on the dressing and smelting of lead ores, its presence has perhaps been more of a curse than a blessing to the miners and smelters of that province. For several years, however, shipments of zinc concentrate has been made to smelters in the United States, these shipments rising to about 9000 tons per year. The amount of zinc concentrate that was shipped to the United States is only a small part of that which would be available if suitable methods for its treatment were developed, and Canadian ores should furnish enough for the normal Canadian requirement. Owing to the long freight haul, United States duties, and other drawbacks, these sales have not been very profitable, and several attempts have been made to smelt the ores in Canada. In the year 1904, a zinc smelter was erected at Frank, Alberta, but proved unsatisfactory and was abandoned, largely because the majority of Canadian zinc ores were unsuitable for treatment by the standard method of smelting.

The electric smelting of zinc appeared, for a time, to offer a means for the treatment of the British Columbia ores, and experiments were made at Nelson in 1908 by F. K. Snyder, and at McGill University in 1910 and Nelson in 1913 by the Department of Mines. Owing mainly to a serious difficulty in regard to the condensation of zinc in the electric furnace, none of these experiments has led to commercial operation In the meantime, experimenters had been looking into the possibility of leaching and electrolytic methods for treating the British Columbia ores. The methods employed here cannot be considered as new except in points of detail; they have been tried many times before and have in general been found unsuitable for commercial use. With the inducement of the present high prices of spelter, the problem was taken up with renewed energy, and technical success obtained; while arrangements have now been completed with the British War Office, the Dominion Government, and the Shell Committee that will enable the manufacturers to proceed with the production of spelter on a commercial scale. The methods employed by different metallurgists differ in detail, but the process consists generally in roasting the ore, thus forming oxide and sulphate of zinc, which are extracted with the aid of sulphuric acid and water. The zinc sulphate solution is electrolyzed, using insoluble anodes and sheet-metal cathodes. The zinc is deposited in a metallic layer on the cathodes, and sulphuric acid is liberated and is used for the treatment of fresh lots of ore. When, as is usually the case, the ore contains lead as well as zinc, the lead remains in the ore-residue, and can be smelted in the usual way. In making brass for cartridge cases very pure zinc must be used, the ordinary brand of spelter not being pure enough. The British Columbia ores contain so much lead that if they were smelted by the ordinary methods the resulting spelter would be far too impure for use in ammunition-making, so, for this purpose, the electrolytic method can alone be used. The need of a specially pure spelter for the manufacture of ammunition constitutes an important reason for using the electrolytic method, instead of the standard process of zinc smelting, or even the electric furnace method, for the treatment of the British Columbia ores.

Among the companies now engaged in the production of zinc in Canada by electrolytic methods, may be mentioned the Consolidated Mining and Smelting Co. at Trail; the Standard Silver Lead Mining Co., near Silverton, using the French process; and the Weedon Mining Co., using the Watts process in a new plant at Welland. Under present conditions the main idea must be the rapid production of metal to serve the Empire's need, but it is satisfactory to realize that the present situation has served to start a new industry, which, in happier times, will materially benefit the mining and smelting enterprises of British Columbia and other parts of Canada, and will incidently open the way for a considerable increase in industrial metallurgy in the Dominion.

Gold in Minas Geraes, Brazil.—In our August issue we gave a précis of an article by E. C. Harder and R. T. Chamberlin, appearing in the *Journal of Geology* for June, describing the economic geology of the State of Minas Geraes, Brazil. In the August issue of the same periodical the authors proceed to discuss the nature of the ore and diamond deposits. We gave an outline of the description of the iron deposits, written by Mr. Harder and C. K. Leith, in our issue of January 1912, so we confine our present précis to the section dealing with gold.

Gold was known to occur in Brazil in the earliest days of its settlement by Europeans, and it afforded the object of search for many explorers. It was not until the beginning of the 18th century, however, that the great goldfield of Minas Geraes was actively worked. The towns of Sabara, Marianna, and Ouro Preto were founded at that time. The period of activity continued to the middle of the 19th century, after which the industry gradually dwindled. The abolition of slavery in 1889 caused the final abandonment of locally owned enterprises, and since then only two important gold mines have been worked, both controlled by English capital, the Morro Velho, owned by the St. John Del Rey Co., and the Passagem, owned by the Ouro Preto Gold Mines of Brazil. The early workings were shallow open-cuts, or shallow shafts and short adits. These workings were distributed over wide areas, and many towns and villages owe their origin to them. In later days a few mines were sunk deeper, and in addition to those already named, the Descoberto, Gongo Socco, Sao Bento, Pary, Santa Anna, and Maquiné deserve mention.

Gold occurs in three different associations: (*1*) in quartz or sulphide veins, (*2*) disseminated in the iron formation, and (*3*) in stream gravels. Some of the veins are strike veins, and others occur along bedding or schistosity planes. Some are long and continuous, and others short and lenticular. In some places groups of short parallel or intersecting veins are found, while in other places single isolated veins of great extent occur. The veins may occur in the basement complex or in any of the sedimentary formations. (For an account of the various formations, our précis with map in the August issue should be consulted). The great vein of the Morro Velho mine is in the Piracicaba schist, and as our readers are aware this is the most persistent gold vein in the world. The Passagem deposit is an irregular bedding-vein impregnating a thin layer of Batatal schist between the Caraça quartzite and the Itabira iron formation. In the old workings near Ouro Preto, quartz veins are found cutting the Caraça quartzite and the Itabira iron formation.

A great many of the quartz veins of the region are not gold-bearing, but contain flakes of specular hematite. Others are of the quartz-felspar pegmatite variety, and occur in the basement complex and are not auriferous. In the auriferous veins, quartz is sometimes predominant and the gold occurs free in it, but more generally the gold is found in arsenopyrite, pyrrhotite, or pyrite, which occur with variable amounts of quartz. Other minerals occurring in places in or near these veins are calcite, cyanite, biotite, garnet, oligoclase, tourmaline, albite, siderite, and muscovite.

At the Passagem mine, the principal sulphide minerals are arsenopyrite, pyrrhotite, and pyrite, occurring in a gangue of quartz, or of quartz and decomposed oligoclase, strongly impregnated with tourmaline. The oligoclase is altered to calcite and white mica. The other minerals mentioned above occur plentifully. Dr. Orville A. Derby has made a study of the paragenesis of the Passagem minerals, and has established three separate stages of mineralization. He believes that the original quartz-oligoclase deposition was of a pegmatite nature, the material being derived from some intrusive igneous mass, which, however, has not yet been discovered. Though no evidence has been found of igneous intrusions into the sedimentary series, such must be assumed, for the nature of the mineralization leaves no doubt as to its origin. During the deposition of the quartz and oligoclase, garnet, biotite, cyanite, and staurolite were developed locally along the contact, and they occur in the country-rock along the borders of the vein. Crystals of apatite are occasionally found with the garnet, and graphite is also associated with the contact minerals, being found along shearing planes. The second stage of mineralization consisted in the introduction of the tourmaline along cracks and as impregnations into the earlier minerals. This stage was very pronounced, and tourmaline is one of the principal gangue minerals. Its introduction was followed closely by the third stage, the sulphide mineralization, when the arsenopyrite, pyrrhotite, and pyrite were introduced. During both the second and third stages the alteration of the oligoclase to calcite and white mica took place. Both tourmaline and sulphides occur with the white mica and calcite in the decomposed oligoclase masses, their abundance depending on the degree of alteration. There is evidence that the tourmaline and sulphide solutions attacked the contact minerals as well as the vein material.

At the Morro Velho mine, the country rock is Piracicaba schist and the vein is parallel to the bedding. The gangue material is a fine-textured mixture of carbonates (siderite, dolomite, and calcite) with quartz, together with a small amount of albite. The auriferous minerals are chiefly pyrrhotite, with smaller amounts of arsenopyrite, pyrite, and chalcopyrite.

The gold disseminated through the iron formation and the resulting canga, or fragmental iron ore, formed the basis of most of the gold-mining operations in the early days. As a considerable proportion of the iron formation is soft, it could be washed almost as easily as stream gravel. The auriferous zones are irregular, and there is no physical characteristic which makes it possible to judge whether gold is likely to be present or not. This irregular dissemination of the gold makes it impossible to conduct mining operations on a large scale. The gold is of various coarseness, varying from fine dust hardly visible to the naked eye to fragments several centimetres in length, generally platy in form owing to deposition along lamination planes. Veins or lenses of quartz are found in the iron formation and occasionally contain gold. Gold also occurs in the gravels of most streams in the district, and it has been derived chiefly from the iron formation. Natives conduct washing operations along many of the streams at the end of each rainy season.

Overwind Preventers.—The necessity for keeping overwind preventers in proper order is exemplified by the accident at Snibston colliery, Leicestershire, as described by Hugh Johnstone, Inspector of Mines for the Midland and Southern districts, in his annual report for 1914, just published. A shaft, 15 ft. 6 in. in diameter, was being sunk and had reached a depth of about 720 ft. It was fitted with wire-rope guides and the bucket was guided by means of a 'rider.' The winding engines were large, having cylinders 30 in. in diameter by 5 ft. stroke, driving a drum of 15 ft. in diameter on the first motion. The drum was fitted with a powerful brake and the engines were controlled by the 'Perfex' patent overwind and overspeed preventer. A master sinker had descended the shaft in order to give some instructions to the charge-man in the bottom, and after waiting there for a few minutes, the usual signals were given for his ascent. The bucket was raised steadily until it passed through the scaffold to which the guides were anchored and at which it picked up the 'rider.' It was then raised at full speed. When it was half-way up the shaft, and travelling at a speed estimated at about 50 ft. per second, the controlling gear suddenly came into action, and the steam brake brought the winding drum to a dead stop. Owing to its momentum, the bucket appears to have continued to ascend for some distance and then fallen back, causing a violent jerk when its descent was arrested by the winding rope. When the overwind preventer had been readjusted, the bucket was drawn up steadily and the master sinker was found lying in it. His nose had been split and broken, the base of his skull fractured, his left thigh fractured, and he had sustained a compound fracture of the right leg. He died shortly after being removed from the bucket. The action of the 'Perfex' apparatus is controlled by a dashpot charged with oil, which is intended to delay the application of the brake until a few seconds after steam has been shut off. The dashpot was alleged to have been filled with oil on the day prior to the accident, but if this is correct, there must have been some serious leakage, as after the accident it was found to be practically empty. The accident emphasizes the absolute necessity of keeping overwind preventers in perfect order, and also the importance of enginemen realizing that such apparatus is not foolproof and is only intended to supplement, and not to be a substitute for, the engineman's control of the engine. Mr. Johnstone records his opinion that it was a rash and risky thing to attempt to raise a bucket containing a man or men at a speed of anything like 50 ft. per second.

Aluminium Dust as a Precipitant.—In our issue of June 1913, we gave a description of the method of precipitation of silver from cyanide solutions at the Nipissing plant at Cobalt, wherein aluminium dust is employed instead of zinc dust. The aluminium does not replace the silver in the cyanogen compounds, and the reaction is actually effected through the instrumentality of caustic soda, sodium cyanide being regenerated and sodium aluminate being formed. The process was adopted at Nipissing because it was found that with zinc precipitation the zinc taken into the stock solution formed with the arsenic present in the ore a combination inimical to the dissolution of the silver, the substitution of aluminium for zinc showing an increase in extraction of over 4 oz. silver per ton.

Since that time its use has been continued with entirely satisfactory results. In August 1914, G. H. Clevenger presented to the American Institute of Mining Engineers a paper reviewing Mr. Hamilton's original article and criticizing certain points in it, to which the latter replied in an article in the *Engineering and Mining Journal* of March 27, 1915. The most important question raised by Mr. Clevenger was: "Is the aluminium dust process likely to result in a greater final profit than the use of zinc, at plants where zinc in solution is no detriment to a high silver extraction?" This Mr. Hamilton tried to answer in the affirmative, by showing that for a 10-oz. silver ore the additional cost of the process over zinc should not be more than 1c. per ton, against which should be set a saving in cyanide of greater or less amount. Mr. Clevenger questioned such a saving on the ground that all or most of the zinc-potassium cyanide formed in the zinc process was subsequently regenerated and rendered available for doing work, and, on the contrary, even suggested a loss of cyanide in the aluminium process due to adsorption by precipitated aluminium hydroxide.

Mr. Hamilton, while admitting that a variable amount of the zinc double cyanide formed in the zinc process is usually regenerated later on, denied that anywhere near all of it was so rendered available, the proportion not regenerated forming a measure of the cyanide that might be saved by substituting the aluminium process. He also expressed the opinion that while the adsorption of soluble salts by colloidal substances was an acknowledged fact, yet that the figures at the Nipissing indicated that in practice this tendency was small enough to be negligible, probable because, on account of a high caustic content in the solution, aluminium hydroxide was not precipitated, though there was some precipitation of aluminium as calcium aluminate by the small amount of lime added in the mill.

A full-sized working test of the two processes under similar conditions was the only way to settle the theorectical questions raised, and the test was made at the mill of the Butters Divisadero Company. An account of this test is given by E. M. Hamilton and P. H. Crawford in an article published in the *Mining and Scientific Press* for September 11.

The ore treated at this mill is not one of those in the cyaniding of which zinc in solution is detrimental to extraction, so that the chief advantage to be derived from the introduction of aluminium precipitation lay in the possible saving of cyanide by its use. The assay-value is low, being about $2 in gold and 7 oz. in silver, and as 1 oz. of silver combines with alkaline cyanide to the amount of 0·08 lb. KCy or 0·06 lb. NaCy it will be seen that at this mill the conditions are not as favourable as they might be for displaying the capabilities of the process in the economy of cyanide. It was soon found that some modification in the system used at Nipissing would be necessary in order to make it applicable to this ore. The first condition with which the authors had to contend at Divisadero was the acidity of the ore, the lime consumption being 30 lb. of high-grade lime per ton. As stated in Mr. Hamilton's original article, it is essential that lime shall be absent from solution at the time of precipitation, because it reacts with the sodium aluminate and is precipitated in the press as calcium aluminate, yielding at the clean-up a product that it is almost impossible to melt. The cost of substituting caustic soda for lime as a neutralizer would have been prohibitive, while the plausible alternative of adding just the right amount of lime to insure its being all neutralized by the time the ore treatment was finished had the drawback that, though neutralized, it would not necessarily all be removed, because calcium sulphate is rather more soluble in water than the hydroxide, and would be equally precipitated by sodium aluminate should it reach the precipitation system. The second condition that made the Nipissing process inapplicable here was the fact that the slime would not settle satisfactorily without an adequate quantity of lime in solution at the close of ore-treatment, whereas, at the Nipissing, as already stated, the final settlement takes place without trouble in the absence of lime. To overcome these difficulties Mr. Hamilton devised the plan of treating the solution before precipitation with soda ash, thus throwing out the lime as carbonate and substituting caustic soda therefor:

$$Ca(OH)_2 + Na_2CO_3 = CaCO_3 + 2NaOH$$
$$CaSO_4 + Na_2CO_3 = CaCO_3 + Na_2SO_4$$

After several months experimenting on a large scale they succeeded in developing this idea into a smoothly working process, which at the time of writing has been running six months and gives entire satisfaction. It makes it possible to use all the lime necessary for neutralizing and settlement, it yields a lime-free solution for precipitation, and incidentally manufactures the caustic soda necessary for that operation. The idea at first was to add the soda ash to the slime charge at the end of agitation, so that the precipitate of calcium carbonate might be filtered out with the gangue, avoiding a separate operation; but owing to the slow settlement of the slime, caused by the absence of lime, this plan was abandoned, and it was decided to separate the lime from the clear solution just before precipitation of the gold and silver.

During the period covered by the following data the cyanide used was sodium, 130%, costing 21 c. per pound laid down at the mine, the cost of zinc was 7·2 c. per pound, of aluminium dust 26 c., and of soda ash 2·4 c. The aluminium precipitation figures represent averages over three consecutive months, during which the total quantity of ore crushed and cyanided was 28,100 tons. For comparison in zinc precipitation, three recent consecutive months have been taken, the total tonnage being practically the same.

ZINC.
(Tons treated, 28,200)

	Total, lb.	Per ton, lb.	Total cost. $	Cost per ton. $
Cyanide	62,400	2·21	13,104	0·464
Zinc	29,816	1·05	2,146	0·076
Total			$15,250	$0·540

ALUMINIUM.
(Tons treated, 28,100)

	Total, lb.	Per ton, lb.	Total cost. $	Cost per ton. $
Cyanide	38,068	1·35	7,994	0·284
Aluminium	7,700	0·27	2,002	0·071
Soda ash	43,013	1·53	1,032	0·036
Total			$11,028	$0·391

Thus, although the cost of aluminium and soda was 3 c. more than the cost of zinc, yet the aluminium showed a saving of $4222, or 15 c. per ton. The bullion precipitated during the two periods was for the zinc process 134,628 oz. of fine gold and silver, and for the aluminium 173,660 oz. During the latter period the grade of ore was somewhat higher, and also the percentage of extraction, which accounts for the greater quantity of bullion recovered.

Exigencies of space have prevented us reproducing a great deal of interesting matter and comment. Like all Mr. Hamilton's writings, the article is clear, concise, and abundant in detail, and it will be read by all cyanide men.

CURRENT LITERATURE

[*Copies of the original papers and articles mentioned under this heading can be obtained on application to the Technical Bookshop, Salisbury House, London E.C., the book department of The Mining Magazine.*]

Alaska Mining.—In the *Mining and Scientific Press* for September 11, Robert S. Lewis describes the Perseverance gold mine in Silver Bow Basin, Juneau, belonging to the Alaska Gastineau Mining Company.

Gold-Saving.—In the *Engineering and Mining Journal* for September 18, D. F. Carver describes the gold-saving devices employed at the Camp Carson placer mine, Oregon. These consist of arrangements of tables and classifiers.

Coal-Cutters.—At the September meeting of the Institution of Mining Engineers, Sam Mavor read a paper on the use of compressed air for coal-cutters, pointing out many defects in present systems that could be removed.

Interview with Charles Butters.—In the *Mining and Scientific Press* for August 21, T. A. Rickard publishes an interview with Charles Butters, in which the latter gives an outline of his varied and energetic metallurgical career, with comments on the flotation process as applied to the concentration of complex gold and silver ores.

Flotation at Anaconda.—In the *Mining and Scientific Press* for August 28, E. P. Mathewson gives an outline of the flotation process at the Washoe works, Anaconda.

Llallagua, Bolivia.—In the *Engineering and Mining Journal* for September 18, D. Copeland and S. E. Hollister commence an article on tin-ore dressing at the Llallagua Company's mine, Bolivia. We gave some account of this plant in our issue of March 1912.

Ore Dressing at Clausthal.—In the *Engineering and Mining Journal* for September 11, E. Mackay Heriot describes dressing practice on lead and zinc ores at Clausthal, Germany.

Counter-Current Decantation.—In the *Mining and Scientific Press* for August 28, G. W. Wood describes the Rochester Mines plant, Nevada, as a typical illustration of the Dorr continuous counter-current decantation process applied in cyaniding silver ore.

Wolfram in Burma.—In *The Engineer* for October 1, E. Maxwell-Lefroy reviews the wolfram resources of Lower Burma, and discusses the present economic position.

Annan River Tinfield, Queensland.—In the *Queensland Government Mining Journal* for August, E. C. Saint-Smith describes the Annan River tinfield, near Cooktown, North Queensland.

Cuban Iron Ore.—The September *Bulletin* of the American Institute of Mining Engineers contains a paper by James F. Kemp on the geology of the Daiquiri iron-ore deposits, Cuba.

Kent Coalfield.—Part 6 of the *Transactions* of the Manchester Geological and Mining Society contains a paper by Herbert Bolton on the fauna and stratigraphy of the Kent coalfield.

Braden Mines.—The *Engineering and Mining Journal* for September 4 publishes an article by William Braden giving the early history of the Braden copper mines, Chile.

Conditions in Bolivia.—In the *Engineering and Mining Journal* for September 11, Stanley C. Bullock gives his impressions of a journey through Bolivia.

Selling Ores.—The United States Bureau of Mines has published Technical Paper No. 83, by Charles H. Fulton, detailing the commercial transactions involved in selling various kinds of ore. For those unable to obtain this paper, the full abstract given in the *Mining and Scientific Press* for September 11 will suffice.

NEW BOOKS

Industrial Nitrogen Compounds and Explosives. By Geoffrey Martin and William Barbour. Cloth, octavo, 130 pages, illustrated. London: Crosby Lockwood & Son. Price 7s. 6d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

In our last issue we made short mention of a new series of books published by Crosby Lockwood & Son dealing with various branches of industrial chemistry. Far too long have we depended on German technologists for literature, not to say practice, in connection with these subjects, and there have been few books available to English readers describing the production and uses of important commercial chemicals. The book now under review deals with nitrogen compounds. As we have devoted much space in our editorial pages in the issues for July and August, and also in the issue of June 1913, to the exposition of the importance of nitrogen in chemistry, we naturally feel sympathetic with the authors of the book in their desire to spread the knowledge of the subject and to make it easy of access to the average inquirer.

The book contains more matter than might be assumed by judging from the number of pages. The pages are big, the margins small, and much of the type also small. Naturally the information is compressed, and the book is intended rather for the general inquirer than for the expert technologist. Just for this reason it will prove widely acceptable. The first chapter describes the circulation of nitrogen in nature, from the atmosphere to the soil, then to plants and animals, and back to the soil or the air. The next deals with natural deposits of nitrates, and the third with the manufacture of nitric acid from nitrates and from the air, and by the contact process from ammonia. The fourth chapter describes the production of ammonia at gasworks and coke ovens and by modern contact processes either as sulphate or as a liquid. Chapter 5 enters into detail with regard to synthetic ammonia. Chapter 6 describes the manufacture of cyanamide, and Chapter 7 the cyanide and prussiate industries. A short chapter following deals with the manufacture of nitrous oxide. The last chapter is devoted to explosives, and gives a useful outline of the various classes of explosives and the methods of manufacture. Altogether a useful handbook.

Salt in Cheshire. By Albert F. Calvert. Cloth, octavo, 1160 pages, with many illustrations. London: E. & F. N. Spon. Price 21s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

We confess to some amount of admiration for Mr. A. F. Calvert, though his genius in the City has been of the irregular and irresponsible variety. His financial, literary, and sporting record is not unlike that of Horatio Bottomley, and in making this remark we hope we shall not be held for libel by either party. But in spite of certain faults, Mr. Calvert is an able man, and his energy is unbounded. He has given us books on a great variety of subjects, from studies in southern Spain to Nigerian mines and conditions in Brazil, and his account of German South-West Africa, advertised for many months, though not yet published, is sure to be of interest. We have now received, somewhat unexpectedly, a volume from his pen describing the salt industry of Cheshire, a big and weighty volume containing a tremendous amount of collected information Mr. Calvert has been interested in the promotion of companies dealing with processes for recovering salt from brine, and no doubt this was the reason for his energies being applied to the thorough study of the salt industry. This particular interest should be borne in mind by the reader when consulting the chapters on the production of marketable articles from brine It is also well to remember that a short time ago Mr. Calvert published a terrific onslaught on the present system of exploiting the salt deposits. Another circumstance causing an uncomplimentary feeling in our minds is the fact that the author abstracts bodily the account of salt-making given by Agricola from Hoover's translation without acknowledging the source.

With these reservations we can thank Mr. Calvert for collecting this great mass of information. He has delved into the history of the Cheshire salt industry, and of the processes for mining rock-salt, pumping brine, and preparing refined products. He quotes at great length, perhaps at too great length, ancient records at Northwich relating to the leases, legal conditions, etc. A large section of the book is devoted to the geology of the district and to descriptions of various properties and treatment works. Extensive accounts are also given on the subsidences of the surface due to the removal of salt deposits by the raising of brine by pumping, and of the methods of combating the results and providing compensation. His series of photographs and sketches showing the disastrous effects on the buildings in the towns and villages are highly instructive. We believe that the book will be of service to those interested in the exploitation of salt deposits and also to those desiring to obtain information relating to the Cheshire deposits.

Russian Self-Taught. By C. A. Thimm and J. Marshall. Octavo, paper covers, 140 pages. London: E. Marlborough & Co. Price 2s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

This is the 5th edition of a useful handbook belonging to Marlborough's well-known series of guides to foreign languages. With so many English and American mining engineers going to Russia nowadays, this book will be of interest to many of our readers.

Journal of the Iron & Steel Institute. No. 1, 1915. Edited by George C. Lloyd, secretary. Cloth, octavo, 714 pages, illustrated. London: The Institute, and E. & F. N. Spon. Price 16s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

This volume contains the report of the proceedings of the meeting of the Institute held in May last. Probably the Institute has suffered more than any other society from the war, for its membership was cosmopolitan, and the friendliest of relations were observed with German and Austrian, as well as with French, Belgian, and Italian iron men. Adolphe Greiner, head of the Cockerill works at Liége, is the present president, and he is a German prisoner of war. The volume now received is of interest to us owing to the inclusion of a lecture on recent progress in the design of large blast-furnace gas-engines, by Professor Hubert, of Liége University. Another important contribution is that by Professor J. O. Arnold, recounting his early researches into the action of vanadium in steel.

COMPANY REPORTS

Carn Brea & Tincroft.—This company was formed under limited liability laws in 1900 to acquire tin mines in Cornwall, between Redruth and Camborne, that had been worked on the cost-book plan since 1832. In the early days the profits were large, owing to the ore near the surface being rich, but since the present company was formed the yield of concentrate per ton of ore has seldom been over 30 lb. The old tailing heaps were sold to the Cornwall Tailings Co. in 1910, and their chemical assay shows nearly as much tin per ton as is in the ore now being raised, a fact going to show that the ore was richer in days gone by. When the present company was formed, no capital was subscribed for rearranging the underground workings or for providing modern crushing and dressing plant, and the history of the company has shown alternating profits and losses. Four years ago, E. S. King was appointed manager, with the object of infusing new ideas and methods, but unfortunately the necessary capital for effecting improvements was not forthcoming, and though Mr. King was able to reduce costs and make a few rearrangements, little permanent good was done. On the fall in the price of tin the advantages gained disappeared. A year and a half ago, the Carn Brea section was closed and work was concentrated on Tincroft. The report for the half-year ended June 30 shows that 29,693 tons of ore was raised, and that 310 tons of black tin was won, being a yield of 23·4 lb. per ton. The income from the sale of black tin was £27,250, and in addition £2361 was received from the sale of arsenic, and £1964 from the sale of wolfram. After all costs and royalty were paid, the half-year ended with a loss of £24. Considering the shortage of labour owing to the war, the low grade of the ore mined, and the low price of tin, the result cannot be considered unsatisfactory. No information is given in the report as to development, but it is stated that search has been directed in the upper levels for wolfram, for which there is now a satisfactory demand. James Wickett is chairman, and W. Thomas is manager. The capital is £135,553. There are £18,500 debentures, of which £8500 has been issued to Lord Clifden, the owner of the mineral rights, for money advanced to provide improved concentrating plant, and £10,000 issued to the directors as security for the guarantee given by them to the bankers in respect of the overdraft of £10,268.

Lisburne Development.—This company was formed in 1907 for the purpose of developing the Glogfawr group of lead mines at Pontrhydygroes, Cardigan, Central Wales. R. R. Nancarrow is manager. The issued capital is £12,594 in ordinary shares, and £4000 in preference shares, and there are £1140 debentures. No dividend has been paid. The report for the year ended June 30 shows that 11,239 tons of ore was raised, and that 470 tons of lead concentrate was produced. The profit and loss account shows a loss of £379 for the year. The development done recently has been disappointing, for the lodes exposed have been small and patchy. Consequently the reserve at Glogfawr is being rapidly exhausted. It is suggested that other properties, particularly the Penlanfach and Gwaithgoch, should be vigorously developed.

Siamese Tin.—This company was formed in 1906 to work alluvial tin deposits at Ngow, in the Renong district of the Western Siamese States. Cyril K. Butler is chairman and H. G. Scott is manager. The first dredge started in July 1912, a second in August 1914, and a third in January of this year. The issued capital is £120,000. A dividend of 30% was paid for the year ended March 31, 1913, but the profit for the next year, £13,159, was carried forward owing to the dislocation of the tin market at the time the report was issued. The report for the year ended March 31 last shows an income of £57,031 from the sale of concentrate and a net profit, after allowance for depreciation, of £21,629. Adding the balance brought forward the divisible profit was £34,788. Owing to it being impossible to raise the new capital for the new dredges as contemplated before the war, money has been spent out of revenue for this purpose; the directors have therefore decided to write £26,214 off the profit. At the meeting of shareholders, the chairman gave some technical details of the work done. The total yardage was 1,062,100, and the tin concentrate recovered was 602 tons. The average price obtained was £94. 12s. 3d. per ton. The yield per yard was worth 12·88d., the working cost 4·8d., the royalty 1·37d., and the profit 6·7d. For the 5½ months from April 1 to September 16, the dredges handled 703,400 cu. yd., and extracted 416 tons of concentrate. An interim dividend of 10% has been declared for the current year.

Broken Hill Proprietary.—The report now issued covers the half-year from December 1, 1914, to May 31, 1915, after which date the smelting business at Port Pirie was handed over to the Broken Hill Associated Smelters Proprietary Ld., as recorded in our pages at the time. On the outbreak of the war, the Proprietary had undertaken the smelting of lead ore and concentrate produced by other Broken Hill companies, and a fourth furnace was blown-in in December. During the half-year under review 115,374 tons was smelted, of which 18,317 tons was oxidized ore, 95,160 tons concentrate and slime, and 1627 tons residues from zinc retorts. The silver-lead bullion produced was 59,742 tons. During the corresponding half-year a year ago, 102,214 tons was smelted and 48,404 tons of bullion was produced. At the mine, 109,911 tons of ore was raised, and 90,248 tons was sent to the concentrator together with 11,449 tons of dump tailing, and 15,781 tons of lead concentrate was produced, assaying 60½% lead and 28 oz. silver per ton. In addition 80,428 tons of dump tailing and 1712 tons of current jig tailing was sent to the re-grinding mill, where 2119 tons of lead concentrate was recovered, averaging 53% lead and 27½ oz. silver. The flotation plant producing zinc concentrate was re-started on January 28, on a limited market for the output being secured in America. The amount of material treated was 139,763 tons, for a yield of 33,318 tons of concentrate, averaging 47% zinc, 12½% lead, and 6¼ oz. silver. The zinc-smelting plant was employed at full capacity; 7848 tons of zinc concentrate was roasted, and 2471 tons of spelter and 381 tons of blue powder (zinc dust) produced. The accounts show a net profit for the half-year of £196,227, and £118,100 was distributed as dividend, being 2s. per 8s. share. As regards the iron and steel industry, particulars have already been given in our pages, and we need here only record that the works were officially opened by the Governor General of Australia on June 2.

Amalgamated Zinc (De Bavay's).—This company is registered in Melbourne and operates the De Bavay flotation process, treating the zinc tailing produced at the North, South, and Block 10 mines at Broken Hill. It also holds shares in the Minerals Separation & De Bavay's Processes Australia Proprietary Limited, a company formed to pool the royalties accruing from the use of the two processes in Australia. W. L. Baillieu is chairman, and H. W. Gepp is manager. The report for the half-year ended June 30 shows that 156,196 tons of zinc tailing was treated, for a yield of 43,468 tons of zinc concentrate and 420 tons of lead concentrate. These figures are slightly lower than those of the previous half-year, and compare with 247,386 tons, 43,468 tons, and 687 tons during the first half of 1914. The accounts are made on a hypothetical basis of prices, and no dividend can be distributed. The company has contracted for the sale of 70,000 tons of zinc concentrate in America and France.

Mount Bischoff Tin.—The Mount Bischoff tin mine in Tasmania was badly hit by the war, and the first serious setback in its 40 years life was experienced during the latter half of 1914. The report for the half-year ended June 30 last provides better reading. The ore mined was 55,076 tons, and after the rejection of 2889 tons, 52,187 tons was sent to the mill, where 238 tons of concentrate was produced. Before the war the half-yearly output was more than twice as large. At the smelter at Launceston, 227 tons of concentrate was smelted for a yield of 147½ tons of metallic tin. The smelter also treated 1013¾ tons of custom concentrate for a yield of 709 tons of metal. Exploration of the alluvial deposits recently discovered at North Valley Flat has been conducted by means of shallow shafts, and the assays give results varying from 2 to 90 lb. per cubic yard. The reserve of ore at the original mine is 870,000 tons, and on the North Slope and North Valley 850,000 tons. The accounts show a profit of £2793, which is carried forward.

Flinders Copper.—This company was formed in March 1914 as a reconstruction of the Union Consolidated Copper Mines Ld., which in turn was formed in 1911 to acquire from Australian companies copper properties situated at Yudnamutana, near Farina, South Australia, 350 miles north of Adelaide. A smelter having a capacity of 100 tons per day was erected, but was never put to work. The present company was formed with the object of ascertaining whether it was possible to treat the ore by leaching methods. The report now issued covers the period from registration to March 31. With it is published a report by D. D. Rosewarne, in which it is stated that there is sufficient oxidized ore averaging 5% copper to supply a leaching plant of 100 tons daily capacity for many years. It is recommended that this ore should be treated with sulphuric acid, and the copper precipitated from the solution by electrolysis. Mr. Rosewarne visited Butte, Montana, with the object of seeing recent processes devised for leaching low-grade oxidized ores, before making his recommendation to the company. It is of interest to note, in this connection, the appointment, recorded in our last issue, by the South Australian Government, of J. D. Connor to visit American copper districts with a view of suggesting methods of treating the oxidized ores of this State. The company is issuing £12,000 debentures to provide funds for erecting a plant to treat 120 tons of ore per day.

Western Frontier Goldfields.—This company was formed in March 1914 to acquire the Tokosea and Amuagiwah gold mining and timber concession in the province of Aowin Brissa, Gold Coast Colony, adjoining the boundary of the Ivory Coast. Butler Humphreys is chairman and managing director, and John W. Daw & Sons are the managers and engineers. The issued capital is £76,000, of which £50,000 is in ordinary shares issued as purchase price, and £26,000 is in preference shares issued for cash. The preference shares are entitled to 6% cumulative dividend, and to 75% of the profits of the company until 100% dividend has been paid in addition to the 6%; after which they rank equally with the ordinary shares. The work of development and equipment is being done by John W. Daw & Sons, for a sum of £17,050. This contract calls for the sinking of shafts, driving two levels, providing a 10-stamp mill and accessory plant, and milling 15,000 tons of ore. The report now issued covers the period ended June 30 last, and shows that two auxiliary shafts have been sunk on the Tokosea property, each 12 by 6 ft., one to 100 ft. and the other to 130 ft., and cross-cuts driven to the lode at 50 ft. Where the two cross-cuts intersected the lode, the assays showed 6½ dwt. over 18 in., and 12 dwt. over 60 in. respectively. Cross-cuts are now being driven at 100 ft. in both shafts, and intermediate levels at 75 ft. will also be opened. These two shafts are 400 ft. apart. Air-shafts are being sunk, one between the two shafts, and two others farther along the lode on each side. The surface plant is erected and should by now be running at half capacity on ore obtained from the intermediate and 100 ft. levels. The stamps were started in May on dump and outcrop ore, and during a conditioning run of 152 hours treated 272 tons for a yield of gold worth £301, being an extraction of 5·2 dwt. or 22s. per ton milled.

Rooiberg Minerals Development.—This company was formed under Transvaal law in 1908 for the purpose of reopening ancient tin mines in the Rooiberg range of mountains, about 75 miles to the northwest of Pretoria. The company was promoted by the Oceana Consolidated, but the control passed shortly afterward to the Anglo-French Exploration Co. Edward J. Way is consulting engineer and E. R. Schoch is manager. Operations started with a small experimental mill, and in 1912 a new mill was built consisting of 10 stamps, a tube-mill, tables, and slime-plant. The report for the year ended June 30 shows that 24,836 short tons of ore was raised from the mine, and together with 3638 tons taken from the dump, sent to the sorting plant, where 2141 tons of waste was removed, the remainder, 26,333 tons, being sent to the mill. In addition 10,873 tons of accumulated middling and slime were re-treated. The average assay value of the 37,263 tons of ore and re-treated material was 2·82% metallic tin and the percentage of recovery 78%. The final tailing averaged 0·57% metallic tin. The amount of tin concentrate obtained was 1055 long tons averaging 69% metal. The revenue from the sale of concentrate was £109,249, and the working profit £29,924, out of which £22,500 was distributed as dividend, being at the rate of 12%. During the previous year 40,643 tons of ore and re-treated material yielded 1294 long tons of concentrate, selling for £152,889, and giving a working profit £55,805, out of which £31,500 was distributed as dividend. Further experimentation has been conducted with a view of improving the extraction. Of the final tailing about 40% consists of minus 200-mesh material assaying from 1 to 1·4% metallic tin. It has been found that about half of this tin can be recovered on Deister tables, and an installation of these is to be erected. As regards development at the mine, the results have been fairly satisfactory, and additional ore has been disclosed at several points. The reserve is estimated at 14,714 tons averaging 4% metallic tin, and in addition 3516 tons averaging 6·3% is in the surface dumps, while 7975 tons of accumulated middling and slime averaging 2·5% remains for treatment. A year ago the figures were 20,097 tons averaging 4·95%, 4292 tons averaging 8·2%, and 18,848 tons averaging 2·5% respectively. During the year the working cost was reduced from 47s. 9d. to 42s. 8d. per ton.

New Modderfontein Gold.—The company belongs to the Central Mining—Rand Mines group, and was formed in 1888 to acquire property in the far east Rand. Milling commenced in 1892 with 10 stamps, and was continued in a desultory way during the next few years. In 1896 a new 60-stamp mill was built, and the mine then became a regular producer. Additional plant has since been added from time to time, and since 1909 the number of stamps has been 180. There are also 7 tube-mills. As recorded in our pages last month, a second milling plant is to be erected, and the capacity raised from 50,000 to 90,000 tons per month. The new plant will be near the mouth of the Circular shaft and will treat the ore from the deeper levels of the mine. The report for the year ended June 30 shows that 738,300 tons was raised, and after the rejection of 17% waste, 611,800 tons was sent to the mill. The yield of gold by amalgamation was 184,208 oz. and by cyanide 94,678 oz., a total of 278,886 oz., worth £1,619,691, being an extraction of 38s. 3d. per ton milled. The working cost was £486,241 or 15s. 11d. per ton, leaving a profit of £683,450 or 22s. 4d. per ton. Out of the profit, £38,772 was applied to capital expenditure, £92,963 was paid as taxes, and £437,500 was distributed as dividend, being at the rate of 31¼%. The new capital provided in 1910 has been exhausted, and in future all expenditure on development and on the Circular shaft will have to come out of revenue. It is noteworthy that the sorting is now closer than before, the figure for last year, 17%, comparing with 5% the previous year. The cost per ton has been reduced by 1s. during the year. As regards development, the blocks adjacent to the Circular shaft are irregular in content and of lower grade than those in some other parts of the mine. The reef is comparatively thin and poor, just as it is in the levels above worked from the No. 12 incline shaft. As the drifts progress farther east and west, the reef improves in quality. For these reasons it has been deemed best to reconsider the value of the deposits exposed by development from the Circular shaft, and the reserve in this section of the mine has been transferred to 'partly developed ore.' Of this, 1,000,000 tons is reported, and further development is now being undertaken to ascertain its value. The proved reserve in the upper levels of the mine, excluding ore left in pillars, is estimated at 5,719,000 tons averaging 8·2 dwt.

Nourse Mines.—This company was formed in 1894 as the Nourse Deep to acquire properties on the dip of the Henry Nourse in the central part of the Rand. In 1905 the outcrop mine was absorbed, as was also the South Nourse in 1909. The control is with the Central Mining—Rand Mines group. Mining operations present considerable difficulties owing to the unusual number of dikes and faults. During the last two years development has been conducted on an extensive scale. According to the report for the year ended June 30, both the ore milled and the ore developed show a fall in gold content. The ore raised was 700,570 tons, and after the rejection of 14% waste, 602,950 tons was sent to the mill, which contains 260 stamps and 7 tubes. The yield of gold by amalgamation was 137,466 oz., and by cyanide 50,757 oz., a total of 188,223 oz., worth £789,481, being an extraction of 26s. 3d. per ton milled. The working cost was £631,437, or 21s. per ton, leaving a profit of £158,043, or 5s. 3d. per ton. As compared with the previous year, the yield per ton milled was 2s. 5d. lower, and the working profit £34,183 less. Out of the profit, £113,825 was distributed as dividend, being at the rate of 13¾%, as compared with 18¾% the year before. The ore developed during the year amounted to 892,300 tons, averaging 5½ dwt. per ton. The total reserve was estimated at 2,952,400 tons, averaging 5·7 dwt., showing an increase in the tonnage of 478,700 tons and a decrease in assay-value of 0·7 dwt.

The Mining Magazine

Scientia non habet inimicum nisi ignorantem.

EDGAR RICKARD, *Managing Director.* H. FOSTER BAIN, *Editor.* EDWARD WALKER, *Assistant Editor.*

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QUOTATIONS

of leading mining shares on the London Market.
Shares are £1 par value except where otherwise noted.
Quotations are given in shillings.

GOLD, SILVER, DIAMONDS:	July 1 1914	Oct. 1 1915	Nov. 2 1915
Rand:			
Bantjes	14	5	6
Brakpan	51	62	65
Central Mining (£12)	160	125	125
Cinderella	6	4	4
City & Suburban (£4)	52	41	42
City Deep	66	64	66
Consolidated Gold Fields	43	26	25
Consolidated Langlaagte	35	37	37
Consolidated Main Reef	18	20	19
Crown Mines (10s.)	120	77	72
D. Roodepoort Deep	17	14	15
East Rand Proprietary	33	22	22
Ferreira Deep	47	42	42
Geduld	23	33	32
Geldenhuis Deep	26	20	20
Gov't Gold Mining Areas	23	26	26
Heriot	55	57	59
Jupiter	5	6	6
Kleinfontein	24	23	24
Knight Central	8	12	13
Knight's Deep	35	25	24
Langlaagte Estates	20	18	18
Luipaard's Vlei	10	7	7
Main Reef West	7	7	6
Meyer & Charlton	115	106	105
Modderfontein B	89	110	111
Modder Deep	58	100	102
Modderfontein, New (£4)	263	307	301
Nourse	27	21	20
Rand Mines (5s.)	120	83	82
Randfontein Central	17	12	11
Robinson (£5)	57	28	27
Robinson Deep	33	21	21
Rose Deep	43	34	32
Simmer & Jack	12	8	8
Simmer Deep	1	2	3
Springs	11	25	27
Van Ryn	67	54	52
Van Ryn Deep	47	51	54
Village Deep	40	36	35
Village Main Reef	40	22	22
Witwatersrand (Knight's)	71	57	57
Witwatersrand Deep	48	34	29
Wolhuter	14	11	12
Rhodesia:			
Cam & Motor	19	14	14
Chartered	17	10	9
Eileen Alannah	11	6	8
Eldorado	18	9	9
Enterprise	9	5	5
Falcon	14	8	8
Giant	14	5	9
Globe & Phœnix (5s.)	32	27	25
Lonely Reef	27	20	20
Shamva	46	37	36
Wanderer (5s.)	3	1	1
Willoughby's (10s.)	7	4	4
Others in South Africa:			
De Beers Deferred (£2 10s.)	330	200	222
Glynn's Lydenburg	11	10	9
Jagersfontein	78	56	62
Premier Diamond Defer'd (2s. 6d.)	152	80	85
Sheba (5s.)	4	3	3
Transvaal Gold Mining Estates	37	32	30
West Africa:			
Abbontiakoon (10s.)	8	8	7
Abosso	14	8	7
Ashanti (4s.)	16	17½	17½
Broomassie (10s.)	2	½	½
Prestea Block A	15	8	9
Taquah	15	14	14
West Australia:			
Associated Gold Mines	7	4	3
Associated Northern Blocks	7	4	3
Bullfinch	6	6	6
Golden Horse-Shoe (£5)	43	39	40
Great Boulder Proprietary (2s.)	14	15	15
Great Boulder Perseverance	2	1	1
Great Fingall	9	2	1
Ivanhoe (£5)	50	44	45
Kalgurli	36	19	15
Sons of Gwalia	23	16	14
Yuanmi	3	2	2

* Denomination of shares recently changed from £5 to £10.

Gold, Silver, *cont.*	July 1 1914	Oct. 1 1915	Nov. 2 1915
Others in Australasia:			
Blackwater	16	15	15
Consolidated Gold Fields of N.Z.	13	11	11
Mount Boppy	10	7	7
Mount Morgan	52	40	40
Progress	10	5	5
Talisman	33	21	15
Waihi	42	36	35
Waihi Grand Junction	25	21	20
America:			
Alaska Treadwell (£5)	162	130	130
Buena Tierra	15	10	14
Butters Salvador	20	15	15
Camp Bird	9	4	8
Canadian Mining	—	8	8
Casey Cobalt	13	5	5
El Oro	14	7	11
Esperanza	15	7	11
Kirkland Lake Proprietary	74	27	25
Mexico Mines of El Oro	97	64	85
Oroville Dredging	10	14	14
St. John del Rey	15	15	16
Santa Gertrudis	11	7	10
Tomboy	22	20	21
Tough-Oakes	28	7	7
Russia:			
Lena Goldfields	43	30	31
Orsk Priority	7	9	9
India:			
Champion Reef (2s. 6d.)	11	11	10
Mysore (10s.)	93	80	80
Nundydroog (10s.)	27	25	26
Ooregum (10s.)	23	23	23
COPPER:			
Anaconda (£10)	126	314*	355*
Cape Copper (£2)	60	50	50
Chillagoe (10s.)	1	½	½
Cordoba (5s.)	6	2	2
Great Cobar (£5)	3	2	3
Great Fitzroy (5s.)	½	½	½
Hampden Cloncurry	27	28	28
Kyshtim	55	37	38
Messina (5s.)	15	14	14
Mount Elliott (£5)	55	55	55
Mount Lyell	23	22	22
Rio Tinto (£5)	1355	1080	1085
Sissert	25	21	21
South American Copper (2s.)	22	12	12
Spassky	52	40	36
Tanalyk	78	36	35
Tanganyika	40	23	24
LEAD-ZINC:			
Broken Hill:			
Amalgamated Zinc	28	25	25
British Broken Hill	36	19	19
Broken Hill Proprietary (8s.)	36	44	44
Broken Hill Block 10 (£10)	32	16	16
Broken Hill North	52	39	37
Broken Hill South	175	125	124
Sulphide Corporation (15s.)	26	17	19
Zinc Corporation (10s.)	19	12	12
Asia:			
Burma Corporation	28	31	29
Irtysh Corporation	—	32	32
Russian Mining	31	15	14
Russo-Asiatic	151	81	79
TIN:			
Nigeria:			
Bisichi	8	5	4
Jos (5s.)	5	4	3
Kaduna (5s.)	15	15	15
Naraguta	17	11	10
N. Nigeria Bauchi (10s.)	3	2	1
Rayfield	5	2	2
Ropp (4s.)	100	13†	14†
Other Countries:			
Aramayo Francke	31	27	27
Briseis	5	4	4
Cornwall Tailings	17	12	10
Dolcoath	11	5	5
Geevor (10s.)	5	1	1
Gopeng	27	27	27
Mawchi	20	5	7
Pahang Consolidated (5s.)	7	6	7
Renong Dredging	36	20	20
Tekka	55	57	55
Tronoh	26	30	26

† Denomination of shares recently changed from £1 to 4s.

METAL MARKETS

COPPER.—The market during October has been featureless and price movements have been of small importance. The turnover on the Metal Exchange has fallen off considerably. The Government is the most important buyer for munitions, consumers engaged in such work obtaining their supplies direct from them. Other consumers are only moderate purchasers at present. Other industries are economizing. The electrical trade, for instance, shows an enormous decline in buying power. Imports continue large, however, especially from America. Japanese shipments are falling off owing to the demand for munition work in that country. Chilean supplies show an increasing tendency to move to New York. Second-hand sellers have shown little enterprise, and the market in America seems entirely in the control of the producers. Their price is 18 cents, and we can see no indication of any coming change in this figure. Freight is becoming even more difficult than in the past. Enormous orders are held up for this reason. In many directions this difficulty is increasing.

Average prices of cash standard copper: October 1915, £72. 13s. 7d.; September 1915, £69. 1s. 2d.; October 1914, £50. 6s. 10d.

TIN.—The tone of the market underwent a decided change toward the end of the month, and prices which stood around £150 when the month opened, had risen to £160 when it closed. The change in sentiment has been accompanied by the usual crop of rumours which are a feature of manipulated markets. Demand both in South Wales and America, in spite of protest of declining trade, has certainly grown more lively. Deliveries in the United States are given as 5000 tons for the month, while shipments from the Straits owing to the scarcity of freight accommodation are estimated to be no more than 4000 tons. It is probable that the famine in steamers will play an important part in the devolopment of the market. Already the contango on forward metal established recently has disappeared, and a backwardation of about 30s. is again ruling. Although arrivals are smaller, more metal is being transhipped in London to New York. The American trade indeed has shown more elasticity than for some months past. A good many orders for tinplates have been booked on this side, consequent on the rise agreed for the finished article, and buyers have not hesitated to take advantage of the present level of tin to buy forward, and even up to March delivery. Russia shows some interest, but with the close of Archangel for the winter no important business has been put through. The holders of Banca and Billiton have at last reduced their prices to a level that will permit of business.

Average prices of cash standard tin: October 1915, £151. 16s. 2d.; September 1915, £152. 18s. 4d.; October 1914, no quotation.

LEAD.—Supplies have been coming in from Spain fairly steadily, but the Australian product is finding its way for the most part to the far east, and American is hampered by freight difficulties. The closing of Archangel has stopped the Russian trade through that port. A demand has set in through Vladivostok, however, which may possibly absorb the tonnage hitherto passing through the White Sea. English consumers are still steady buyers of good round quantities apart from ammunition requirements. In spite of high prices, supplies are not increasing, and a falling off in Spanish shipments is threatened, for which scarcity of labour appears to be responsible. Freight difficulties are increasing and affecting both import and export of lead. The American price again shows signs of manipulation, and now stands at 5 cents per lb.

Average prices of soft foreign lead: October 1915, £23. 19s. 9d.; September 1915, £23. 3s.; October 1914, £17. 9s. 11d.

SPELTER.—This market has become firmer, the rise in prices being due largely to transport difficulties. America is using the strength of the market to sell forward. Business is reported for January to May at 12½ cents. For near delivery they are above London parity. Their increased production will probably make itself felt shortly. Russian demand has revived.

Average prices of good ordinary brands: October 1915, £66. 10s. 11d.; September 1915, £67. 17s. 9d.; October 1914, £23. 13s. 6d.

ANTIMONY.—The market continues to be purely nominal, and no quotation is given. Presumably the price remains about £120 per ton for refined metal, and £70 per ton for Chinese crude. In an Editorial Note we give particulars of the use of antimony in shrapnel shot.

QUICKSILVER.—The price for Spanish quicksilver gradually advances, and is now £16 10s. per flask of 75 lb. Explosive makers are attempting to extend the application of organic substitutes for fulminate.

PLATINUM.—The quotation has been raised to 198s. per ounce. An embargo has been placed on the export of platinum from this country. Elsewhere in this issue we say something of industrial substitutes.

BISMUTH.—10s. per lb.

COBALT.—96 to 98% pure metal, 8s. per lb.

CADMIUM.—7s. per lb.

MOLYBDENUM.—The market for molybdenum is fairly active, and the demand continues. The nominal quotation is steady at 105s. per unit for ore averaging 90% MoS_2. Ferro-molybdenum, 65 to 85% metal, 18s. per lb. of metal contained.

IRON.—The pig iron market is active and cheerful, and the demand for hematite brands on the part of the Allies is strong. No. 3 Middlesbrough is up 3s. at 68s., and hematite is 100s. Manufactured products remain about the same; steel rails £9. 2s. 6d., ship plates £10. Spanish hematite ore still rises, and is now 33s. per ton, as compared with 18s. 6d. a year ago.

TUNGSTEN.—This metal is now under Government control with the price fixed at 55s. per unit. Ferro-tungsten, 80 to 90% low carbon, 5s. 8d. per lb. of metal contained. Tungsten metal powder 5s. 10d. per lb.

ALUMINIUM.—All producers in this country and abroad are sold far in advance, and it is not possible to obtain quotations. The nominal figure is £200 per ton. In America the price is 60 cents per lb.

NICKEL.—There are no free supplies of this metal, and the nominal quotation in this country is £225 per ton, and in America 45 to 50 cents per lb.

CHROME ORE.—Chalas & Sons have put up the price of chrome ore shipped from New Caledonia, Rhodesia, and Beluchistan, the quotation being 120s. to 130s. for 47 to 55% material, on the basis of 50% chromic acid. Ferro-chrome, 4 to 10% carbon, £28 to £32 per ton, basis 60%; 2% carbon, £86 per ton.

MANGANESE.—No change is to be recorded in the quotations of manganese ore, Indian being 20d. per unit, and Brazilian 3s. The restrictions of export of ferro-manganese are being relaxed, especially with regard to America.

SILVER.—For the last two months the price of silver has been gradually strengthening, owing to general demand and the absence from the market of speculative stocks. The price is now 24¼d. per standard ounce.

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,998	363,826	8,794,824	37,358,040
July, 1914	703,136	29,349	732,485	3,111,398
August	684,607	27,311	711,918	3,024,037
September	677,063	25,107	702,170	2,982,630
October	703,985	29,761	733,746	3,116,754
November	685,450	30,386	715,836	3,040,677
December	669,075	26,062	695,137	2,952,755
Year 1914	8,033,567	344,570	8,378,139	35,588,075
January 1915	689,817	25,167	714,984	3,037,058
February	653,213	23,008	676,221	2,872,406
March	727,167	26,768	753,935	3 202,514
April	717,225	26,855	744,080	3,160,651
May	737,752	25,796	763,548	3,243,347
June	727,924	27,356	755,280	3,208,224
July	742,510	27,845	770,355	3,272,258
August	749,572	29,191	778,763	3,307,975
September	749,235	27,515	776,750	3,299,423
October	769,798	27,833	797,631	3,388,122

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
July 31, 1914	167,006	9,257	13,656	189,919
August 31	168,851	9,485	—	178,316
September 30	169,619	9,389	—	179,008
October 31	170,438	9,212	—	179,650
November 30	166,039	8,990	—	175,029
December 31	164,650	8,704	—	173,354
January 31, 1915	172,331	8,675	—	181,006
February 28	180,422	8,494	—	188,916
March 31	185,239	8,216	—	193,455
April 30	186,941	8,418	—	195,359
May 31	183,961	8,857	—	192,818
June 30	184,155	9,019	—	193,174
July 31	190,026	9,371	—	199,397
August 31	196,866	9,943	—	206 809
September 30	204,833	9,743	—	214,576
October 31	210,017	9,513	—	219,530

Cost and Profit on the Rand.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Year 1912	25,486,361	29 2	19 3	9 11	12,678,095
Year 1913	25,628,432	27 9	17 11	9 6	12,189,105
Year 1914	25,701,954	26 6	17 1	9 0	11,553,697
January 1915	2,237,748	25 10	17 5	8 3	920,194
February	2,077,792	26 4	17 11	8 4	867,782
March	2,366,392	25 9	17 4	8 4	985,511
April	2,289,002	26 4	17 5	8 9	996,846
May	2,416,966	25 8	17 0	8 6	1,031,220
June	2,346,493	26 1	17 2	8 8	1,017,908
July	2,395,397	26 1	17 4	8 7	1,027,332
August	2,418,447	26 2	17 2	8 9	1,056,854

The above are the official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 70% of the working profit.

Production of Gold in West Africa.

Year 1912	Year 1913	Year 1914	Sept. 1915	Year 1915
£1,497,179	£1,634,700	£1,727,044	£135,744	£1,284,241

Production of Gold in Rhodesia.

Year 1912	Year 1913	Year 1914	Sept 1915	Year 1915
£2,707,368	£2,903,267	£3,530,207	£321,085	£2,838,663

Gold Output of India.

Year 1912	Year 1913	Year 1914	Oct. 1915	Year 1915
£2,265,094	£2,299,315	£2,340,259	£195,521	£1,969,153

Production of Gold in Western Australia.

	Export oz.	Mint oz.	Total oz.	Total value £
Total, 1913	86,255	1,227,888	1,314,143	5,582,140
July, 1914	8,294	88,305	96,599	410,324
August	101	102,346	102,447	435,164
September	1,535	103,577	105,112	446,485
October	2,028	99,366	101,394	430,692
November	1,217	109,282	110,499	469,387
December	1,214	101,534	102,748	476,253
Total, 1914	51,454	1,181,520	1,232,974	5,237,308
January 1915	561	98,196	98,757	419,495
February	607	103,661	104,258	442,900
March	1,829	91,872	93,764	398,282
April	1,017	101,592	102 609	435,853
May	2,311	101,359	103,670	440,360
June	1,273	100,036	101,309	430,333
July	555	98,859	99,414	422,271
August	1,079	99,941	101,020	429,103
September	2,019	100,833	102,852	436,885
October	2,346	100,238	102,584	435,747

Other Australian Gold Production.

	1913	1914	Sept. 1915	1915
	£	£	£	£
Victoria	1,847,400	1,740,300	138,900	1,055,400
Queensland	1,118,610	1,011,310	79,470	807,810

Exports of Copper from United States
(Reported by United States Customs).

Month	Long Tons	Month	Long Tons
July, 1914	34,145	March, 1915	29,725
August	19,676	April	20,481
September	23,866	May	25,785
October	28,995	June	15,751
November	20,170	July	16,812
December	16,830	August	16,289
January, 1915	28,197	September	14,327
February	12,066		

Nigerian Tin Production.
In tons of concentrate of unspecified content.

Year 1912 tons	Year 1913 tons	Year 1914 tons	Aug. 1915 tons	Year 1915 tons
2,532	5,032	4,832	438	3,288

Production of Tin in Federated Malay States.
Estimated at 70% of concentrate shipped to smelters.

1911 tons	1912 tons	1913 tons	1914 tons	Sept. 1915 tons	1915 tons
43,967	48,250	50,128	49,042	3,932	35,840

Sale of Tin Concentrate at Redruth Ticketings.

	Tons	Value	Average
Year 1911	6151¼	£702,599	£114 4 5
Year 1912	6492	£831,908	£128 5 6
Year 1913	6186	£744,268	£120 2 6
Year 1914	4987	£432,437	£86 14 3
January to June 1915	2826	£261,958	£92 13 10
July 5	202	£18,721	£92 13 5
July 19	204½	£18,102	£88 10 5
August 3	177	£15,069	£85 2 9
August 16	171	£14,098	£82 9 0
August 30	156	£12,935	£82 18 5
September 13	149	£12,554	£84 5 1
September 27	171½	£14,459	£84 6 3
October 11	166	£13,620	£82 1 0
October 25	164	£13,981	£85 5 0

Imports of Tin Concentrate into United Kingdom.

	October		Year 1915	
	Tons	Value	Tons	Value
		£		£
South America	2,494	185,362	29,129	2,420,687
Other Countries	718	65,960	7,970	741,638
Total	3,210	251,322	37,099	3,162,325

REVIEW OF MINING

Introductory.—It is a pleasure to be able to begin our review this month with definite announcement of progress in the reorganization of the mineral industry that the war has shown to be so much needed. The project for co-operative studies of tin dressing under direction of the Institution of Mining and Metallurgy has assumed such definite form as to assure that actual work will soon be under way. Mr. W. M. Hughes, the minister who has been so active in breaking up the German monopoly of the metal and ore trade in Australia, has become Prime Minister, succeeding Mr. Fisher, who is coming to London as High Commissioner for the Commonwealth. It is perhaps significant that Mr. Tilden Smith, who recently bought the Swansea Vale zinc smelter in Wales, stated at the meeting of the Burma Corporation that, while he did not expect the zinc industry to receive aid from the Imperial government, he did anticipate that Australia would do something. Canada, as we have already announced, has agreed to a bounty for a limited time if prices fall below a fixed standard. American firms are also active. The American Smelting and Refining Company is putting into effect more direct selling methods, and will hereafter be more of a factor in the London copper market. The Southern Aluminium Company, which was caught by the war with an unfinished plant, is taking in additional American capital to complete its works. The company was owned jointly by the American Metal Co., which is affiliated with Henry R. Merton & Co. and the Metallgesellschaft, and French interests. The German element in the concern will hereafter be subordinate. Aluminium, incidentally, has advanced greatly in price. In lead production the Burma Corporation is planning active smelting of its lead-silver ore, and will rapidly increase its output. Both the Hercules and the Bunker Hill & Sullivan companies in the Coeur d'Alene region are planning to go it alone in smelting. The Hercules has bought the Northport smelter, while the Bunker Hill & Sullivan will build a new plant. Mr. Fred W. Bradley and his associates in this company have had experience in lead smelting, having developed the Tacoma plant now owned by the American Smelters Securities Co. Mexico is settling down, and Mexican shares have risen in value. They suffered a setback as it came to be realized that at best recovery is bound to be slow, but on the whole the Mexican situation is distinctly better. The best political news of the month was Botha's victory at the polls in South Africa. Following his brilliant campaign in Damaraland it comes as a well-deserved recognition. The collapse of the Labour party does not seem to have been anticipated, but was none the less welcome. To us it seemed all the more certain when the leaders became allied with a party tainted with disloyalty. Every right thinking man sympathizes with any well directed effort to improve conditions of labour, but national interests must be put above those of any class, if any effective appeal is to be made to opinion outside it, and this is true of labourers as of others. In reconstruction in Damaraland, Botha is showing the same large view that characterized his military operations. A mine inspector has been appointed, but new mining claims are not to be acquired until the status of the country is finally settled. This is as it should be, even though it temporarily checks impatient prospectors. In Russia, the Malay States, Australia, all around the world, the mining industry is accommodating itself to new conditions and laying foundations of permanent value.

Transvaal.—The output of gold on the Rand during October was 769,798 oz., and in other districts 27,833 oz., making a total of 797,631 oz., worth £3,388,122, as compared with 776,750 oz., worth £3,299,423 in September. The number of natives employed in the gold mines on October 31 was 210,017, as compared with 204,853 on September 30, and 170,438 on October 31, 1914.

'German' South-West Africa is now a military protectorate, and discussion as to its future is suspended until the end of the war. The wives and families of men employed in the provisional service on behalf of the Union Government are not allowed to accompany them, and strict supervision prevents the entry into the country of undesirable people, such as those who desire to jump claims or negotiate with the natives for mineral deposits.

The boom in Knight Central shares has continued during the month, following the receipt of a cable mentioned in our last issue announcing the discovery of ore averaging 21·9 dwt. over 40 in. at the lowest level below the dike. That cable referred to the Main Reef. A second cable stated that the upper portion of the South Reef on the same level gave an assay-value of 12·5 dwt. over 60 in. No further information has been given as to the developments on the Main Reef from the point of intersection in the cross-cut.

Last month we recorded the serious fall of rock in the Village Main Reef on September 27, and our Johannesburg correspondent refers to the matter in this issue. Another similar accident happened on October 23, when hanging wall collapsed in a stope and killed five natives. It is stated that this fall cannot be attributed directly to the recent shifting of ground.

The Nigel mine in the Heidelberg district has yielded poor ore of recent months, and at one time the manager felt constrained to advise the suspension of milling and the extension of development. It was decided, however, to continue milling on a decreased tonnage, mining only the best ore. In the meantime a large ore-shoot recently discovered is being developed in order that an idea may be gained of its extent and assay-value. The position will be afterwards re-considered in the light of the results obtained. This mine has been working since 1888, and though the days of handsome profits may be gone, the help its records will afford in the elucidation of the geology of the Far East Rand will keep its name alive.

Rhodesia. — The output of gold for September was worth £321,085 as compared with £344,493, the record figure. The abnormally high figure for August at Golden Kopje was not maintained, and the output was £10,292 from 11,465 tons of ore, as compared with £11,492 from 10,020 tons during August and £8743 from 12,020 tons during July. Lonely Reef, Shamva, and Rezende also showed slight declines.

West Africa.—The output of gold during September was worth £135,744 as compared with £139,364 for August and £154,316 a year ago. The big mines showed little variation, but the Broomassie was lower again with £3413, as compared with £4344 in August and £6035 in July.

The Broomassie mine is exhausted, in spite of intelligent efforts to find more ore, and milling was suspended last month. The treatment of accumulated concentrate will keep the cyanide plant occupied for a month or so, and afterward re-treatment of old residues will be undertaken.

Australasia.—Our West Australian correspondent gives interesting details of the conditions at the Chaffers mine in the northern part of Kalgoorlie district. We have made reference several times recently to the difficulty of providing funds for continuing work at this mine. A scheme put forward in London was not acceptable to directors or shareholders. It is stated that a better offer has been received and is likely to be accepted.

The Queensland Mines Department has arranged with the British Government, for a period of twelve months, to acquire for the home authorities all the molybdenite, wolfram, and scheelite produced in the State. The price fixed for molybdenite is 105s. per unit of MoS_2, and that for wolfram and scheelite 55s. per unit of WO_3. The Queensland Government is following the lead of other Australian States in the matter of establishing state coal mines. Three properties are to be acquired.

In our April issue we referred at some length to the plan based on Mr. Pellew-Harvey's report for the re-opening of the Great Cobar copper mine. According to the latest information, £62,000 of the £102,000 required has been subscribed by debenture holders, and £40,000 has been provided by the New South Wales Government. Judging by the Australian papers, the government grant was not obtained without much combating of local opposition.

The Australian Government is taking active steps to keep the control of the metal output within the empire. The fact that Mr. W. M. Hughes, who has actively championed this course, has succeeded to the office of Prime Minister, indicates that the policy is popular. A metal exchange has been inaugurated, and the destinations of material sold are to be disclosed. Stringent regulations restrict membership to British firms. No firm is to be a member unless four-fifths of the capital is owned by British subjects, and each firm must show that it is not mainly controlled, directly or indirectly, by the subjects of any foreign country.

The progress of the Broken Hill Proprietary as a steel producer is indicated by the fact that shell steel is now being made on the Woolwich specification. An ample supply of approved steel is available for local shell manufacture. The steel is also on offer to England and the Allies.

Our West Australian correspondent records that after vain attempts to secure amendment to the Mines Regulation Act, the Legislative Assembly has passed a small bill allowing the appointment of check inspectors. The council of the Chamber of Mines of West Australia is now considering it, and probably with several slight alterations, with reference to the limitation of the powers of these inspectors, will allow the bill to go through. The Chamber of Mines realizes that as this concession has been granted to the miners in other parts of the world, it should be accepted in West Australia. The point, however, that they have striven to guard against, and so far in the Lower House have not been successful, is the appointment of Union secretaries and ex-Members of Parliament as inspectors.

The New Zealand Crown Mines company reports that its gold mine at Karangahake has been closed down. The mine adjoins the property of the Talisman, and in the early days from 1895 to 1903 did well for the Exploration Co., in whose control it then was. For some years the workings have been in poor ore, and in spite of vigorous exploration the end has now come. Unfortunately the developments at the neighbouring mine, the Talisman, are none too promising and the reserve is low.

Cornwall.—At the tin ticketing held at Redruth on October 25, a new bidder put in appearance, the London Tin Smelting Co., Ltd., and secured 10½ tons of Basset concentrate and a similar amount of Grenville produce. Mr. Horton Bolitho, and Mr. John Gilbert, the latter being agent for Lord Cliefden, have a small interest in the new company, having taken it for the purpose of helping to create more competition at the ticketings. The chairman of the company is Mr. H. J. Enthoven, the lead smelter at Rotherhithe, who is identified largely with Spanish lead.

In our last issue we recorded that the Cornish Tin Sands company, formed four years ago to treat the accumulated tailing at the mouth of the Red river, was in serious difficulties, owing to a petition for compulsory liquidation having been presented by a firm which had supplied mining machinery. The petition was dismissed by the court, and arrangements have since been made for the restarting of the treatment plant, with certain modifications in the method employed.

Canada.—We treat elsewhere somewhat fully the Kowkash news, and our Toronto correspondent gives details regarding work under way at Cobalt, Porcupine, and elsewhere. We note with interest that as a result of the active work at Anyox, the output of the Granby company totalled 4,000,000 lb. copper in August, the largest production in the history of the company. A 'strike' on Rude creek, near Dawson, in September, proved to be relatively unimportant.

As a result of recent discoveries of nickel ore in the Fond du Lac region, on the north-east side of Lake Athabasca in Northern Alberta, by H. V. Dardier some months since, an expedition to explore the country has been fitted out by Vickers of Sheffield. Mr. Dardier came to England carrying samples of ore in order to interest British capital in developing the country, and has been placed in charge of the exploration party, which has been fitted out for a long stay. The party comprises mineralogists, engineers, and other experts, and a large number of labourers, and left Edmonton during the latter part of September. They took with them $50,000 worth of machinery and equipment, and expect to stay in the Fond du Lac country for about two years. The total cost of the expedition will be at least $100,000.

United States.—Conditions here are steadily improving, and it is anticipated that an active movement of mining shares will shortly follow the present boom in war stocks. In the meantime such substantial and well run companies as the Tomboy continue to do well, and interesting technical developments are under way at many plants.

An interesting announcement made at the annual meeting of the Tomboy company was that of the purchase of the White Cloud group, giving an extension of 4000 ft. on the course of the great vein which has already proved so valuable and profitable. As ore is already known in the ground and the purchase price was only £15,000, the deal is likely to prove a good one for Tomboy shareholders, all the more because the White Cloud can be most economically worked through the Tomboy. It will be remembered that the cost of the Montana was written off out of profits in 1911–12. Indeed, as Mr. Bayliss pointed out, fully 10s. per share of profits have been reinvested in property. In the San Juan the ore shoots, while rich and remarkably persistent, are not usually profitable in depth below certain rhyolite beds. It is necessary therefore for a company to depend upon average and horizontal development rather than deep sinking.

On the Natomas dredge No. 7, in California, the Neill jigs referred to in our issue of August have shown an excellent recovery of rusty gold, previously lost, and four more jigs are to be placed on the boat. Each group of four delivers to a Hardinge mill, where the material is ground just enough to give the gold a bright surface, after which it amalgamates without trouble. This plan may well prove applicable elsewhere. Natomas 4, now building, is to have a re-soiling equipment. There will be two stackers and two tailing sluices, the latter starting 9 ft. above the deck, and discharging 16 ft. beyond the dredge. The upper tumbler is set 7 ft. above its usual position. Yuba 15, also building, is designed to dig 81 ft. below water level. It will have 100 buckets made of manganese steel, and each of 16½ cu. ft. capacity. Marysville 5 is to dig 70 ft. below water level. The scale of operations is indicated by the facts that the two Marysville dredges operated in 1914 dug 4,000,000 cu. yd., and the 10 of the Yuba Consolidated Gold Fields handled 17,000,000.

In Colorado the Derry Ranch dredge near Leadville started late in September, and got into pay ground October 9, after passing through a streak of clay. The first clean-up, October 16, yielded about $7000 from 17,000 cu. yd., and by October 26, $16,000 worth of gold had been sent to the Mint. The boat is an old Union Iron Works dredge completely rebuilt by the New York Engineering Co. Tested ground sufficient for a five years' run is reported ahead of it. In California there is a more cheerful tone, as consumption is gaining on production in the oil fields. One effect has been an increase of 2 cents per gallon in the price of gasoline, or petrol. Labour troubles in Arizona continue, but show no sign of spreading. At Butte both copper and zinc mines are active, the Butte & Superior having milled in September 40,360 short tons, yielding 11,579 tons of concentrate, assaying 55·92% zinc. New zinc furnaces are coming into operation, Denora having begun smelting October 21, four months and ten days after construction began. It is to include 9120 retorts in 10 blocks. The added smelting capacity has not increased as rapidly as was anticipated, and the price of spelter is still high. Closing the Panama Canal will delay delivery of Australian concentrates to American furnaces; several steamers already on the way have been diverted to the Magellan route, and one to San Francisco.

The first unit of commercial plant for treating the brine at Searles lake, California, which is controlled by the Consolidated Gold Fields of South Africa, is now in course of erection. The daily output will consist of 100 tons of potassium chloride and 30 tons of borax, and the other salts will not at present be extracted. The crude product of mixed salts will be shipped to San Pedro, the harbour of Los Angeles, for refining. The works at Searles lake and San Pedro are expected to be ready for operation early in 1914.

Alaska.—Quartz mining at Fairbanks made little progress this year owing, in part at least, to the high cost of fuel and supplies. Operators are mainly waiting for the advent of the railway. Tolovana is attracting more attention, Livingood creek having given splendid results. On Chena creek Frank Berry is planning to operate a dredge next year.

Mexico.—Elsewhere we discuss the new taxes levied upon mines in Mexico and their probable result. The latter must remain somewhat in doubt till the all-important matter of who is to control the country be decided. Carranza continues to consolidate his position. Villa has been forced to give up most of Chihuahua and his anticipated invasion of Sonora has not started brilliantly. The Villa forces have lost Guymas and were not able to capture Agua Prieta. A vigorous attempt at the latter lead to shooting across the line at which the American forces intervened. In advance of Villa's coming, the staff and employees of the Montezuma Copper Co. were withdrawn from Nacozari. The El Tigre mine continued to operate and the Greene-Cananea has kept its furnaces and mill going. The A. S. & R. plants in Mexico are idle and in the hands of Mexican employees. The company reports that there has been little damage done to them. Villa is reported to have ordered the resumption of smelting at Chihuahua under penalty of seizing the plant and running it himself, but seems to have thought better of the latter. With ports closed, warehouses swept clean, and little food left in the country, it is difficult to see how Villa can long maintain any vigorous opposition. In the south the situation is less clear. Oaxaca continues its independent career, and since the American Hawaiian line is sending its ships around the Horn it would seem that the Tehuantepec line is not open. Zapata is quiet but not subdued. The Mexico Mines of El Oro reports that while the plant has not been damaged and development on a limited scale is under way, interruption of transportation prevents operation of the mill. The transportation difficulty is the most serious one at many points, and rehabilitating Mexico will be a big and expensive job. A straw indicating the course of the wind is the loan by New Orleans bankers of $10,000,000 to the Carranza government.

Russia.—Excellent progress is being made in building the Irtysh zinc smelter, which should be ready for operations by the end of the year. The plant will consist of 480 retorts, 240 to a side, arranged in four horizontal rows. Later it is planned to add 20 retorts at the end and two rows on top, and flues and connections are arranged with that in view. Merton furnaces will be used for roasting, and producer gas for firing. The engineers have been fortunate in finding a local clay suitable for all uses. The retorts will be hydraulic-pressed, and the plant will be modern in every detail. Contrary to general impression, labour is not cheap, and so labour-saving devices of all sorts have been installed.

The Spassky company is finally free from litigation with regard to the ownership of some of the claims at Atbasar, based on an alleged irregularity in connection with the staking of six claims. The committee of the Senate gave judgment for the company, but allowed the opponent to appeal provided he could obtain sufficient backing. This support has not been forthcoming, so the company's right to the property is established.

At the Kyshtim copper mines much work has been under way this summer. The interesting feature of the season's work was the buying, moving, and re-building of a railway with equipment all complete. It was a Government line that had not paid, and in view of the needs of the company, the Government allowed it to be sold. The removal began within 36 hours of the close of the sale.

In the chairman's speech at the Kyshtim meeting, an interesting statement was made with regard to the payment of dividends in this country. In the past the necessary funds have been provided by the realization of gold bullion shipped to England for refining. On the outbreak of war, the export of gold bullion from Russia was prohibited, so that the company has now to rely on such banking facilities as are available. As recorded last month the fall in exchange makes it highly undesirable to remit funds to this country at present.

At the Pavoda estate, both the Marion and Putiloff dredges have been giving excellent account of themselves. Working expenses are estimated to be less than 3 roubles per cubic sagene (about 31 pence per cubic yard at usual exchange rates). The Marion dredge is digging about 20 sagenes per hour, 20 hours per day. The ground yields about 1 zolotnik, 6 dolis per cubic sagene (7s. 8d. per cu. yd., about £20 per day). The Putiloff, a $5\frac{1}{2}$ cu. ft. dredge, is on easier ground and working 120 to 150 cubic sagenes per day. A second-hand dredge operating on another part of the estate is in nearly barren territory.

A technical committee has been visiting the Lena goldfields and is now in Petrograd preparing a report. W. E. Thorne has been drilling ground this season selected by C. W. Purington, who has himself been studying the geology of the eastern part of the property. A small hydraulic plant, built of materials on the ground, has been added to the equipment.

Burma.—Most interesting details regarding work present and prospective at the Bawdwin mines were given at the meeting of the Burma Corporation. For the immediate present, attention will be centred mainly on the lead-silver ore and the 100 ton mill will be used, in connection with the smelting plant, to treat this rich ore. It is anticipated that the revenue from this source will be sufficient to meet operating and capital expenditures for the next year, a happy situation. The ore reserve has been increased to 2,000,000 tons and the ore treatment problem is well on the road to solution. Apparently it must be along lines similar to those developed at Broken Hill. In nine to twelve months more the great Tiger tunnel should be completed to connection with the mine, and then, if market conditions warrant, large scale production will become possible. We regret to learn that the attitude of local government officials has not been as sympathetic as it might be, even going so far as to raise the cost of water power development to a point where it was cheaper to adopt oil-driven engines. With the changes in the board and the bringing in of men long connected with Indian development, we hope that better relations may obtain.

Siam.—The Renong Tin Dredging Co. is not doing so well as we expected when we quoted its results in an editorial on 'Successful Mining' in our issue of February 1914. The report for the year ended June 30 shows a loss of £18,009, an unfavourable result that may be attributed to several disadvantageous circumstances. The first dredge erected five years ago had to be rehabilitated and was out of commission for four months. The second and third dredges, erected two years and a year ago respectively, developed certain structural weaknesses, and alterations became necessary. A severe flood in the autumn of 1914 interfered with dredging, and filled the workings with silt, which had to be removed before dredging of the tin ground could be resumed. The clay overburden continued to cause trouble. The results obtained by No. 3 dredge have so far been discouraging, as the yield is not much more than $\frac{1}{4}$ lb. of cassiterite per cubic yard, a much lower figure than the estimated average for the area to be worked. Mr. F. W. Payne, the consulting engineer, has paid a prolonged visit to the property, and he has been able to make many improvements, with the result that the monthly yield of concentrate has substantially increased recently. In spite of the poor results revealed in the report, the prospects are favourable.

Chile.—The nitrate industry is picking up, and shipments to America and the United Kingdom are beginning to compensate for the loss of the German trade, though conditions are still bad, as might be expected from the fact that Germany formerly handled nearly 70% of the material. The total output for 1914 was 40,150,463 quintals. There are ten German ships interned at Antofagasta.

Colombia.—The new cyanide plant being built by A. E. Drucker for the Frontino & Bolivia company will soon be ready to run. It embodies the Dorr apparatus for counter-current slime-treatment.

Notable Deaths.—Vivian B. Lewes was for 26 years professor of chemistry at the Royal Naval College, Greenwich. He was an authority on coal, oil, and gas in relation to their practical applications. As a lecturer in the class-rooms and in public he had few equals.

EDITORIAL

IF there is one thing more than another that is unjust, it is the non-payment of salaries and expenses to members of our profession by companies, while the directors are drawing their fees regularly and keeping up extravagant London offices. More than the usual number of cases of this kind have been reported to us recently. Our advice to engineers in such cases is not to hesitate to take legal steps. Get your pay for services rendered, even if you have to seize the desk of the secretary or attach some director's silk hat.

SAMPLING correctly is at the very basis of all good work in a mill. Refinements in assaying go for nothing if the sample be not really representative, and no method of assaying, simple or complex, is worth following unless a method of sampling of at least equal refinement and accuracy be adopted. We have no great sympathy with the point of view of the Cornish mill man who rejected an automatic tailing sampler because he had given up chemical assaying. The vanning shovel assay, which Mr. Percy Maynard describes on another page, requires high skill and, for its purpose, is sufficiently accurate; but such an assay is of no more and no less value than is the sample.

POTASH exports from Germany have, naturally, decreased greatly, even to neutral countries, since the war opened. Exports of fertilizer salts to the United States for the seven months ended July 31 amounted to 87,135 tons as compared with 597,961 in the corresponding period the year before. With other potash salts the difference was not so great, the figures being 13,562,685 and 23,041,969 pounds respectively. The export of cyanide of potassium actually increased. American fertilizer companies are not feeling particularly cheerful about the result of their long contest with the Kali Syndicate over the alleged breach of contract. While they were awarded damages to the amount of $1,000,000, the Syndicate is paying in potash and has thoughtfully raised the price so as to cover this amount with a profit for good measure! As can well be imagined the work of the Consolidated Gold Fields in developing Californian potash deposits is being watched with keen and sympathetic interest.

CONSIDERABLE mystery has hedged round the subject of the use of lead and antimony in shrapnel, even to the extent of direct denials that they were now employed. Specifications for Russian 3-inch shells, however, call for a loading of 258 to 260 half-inch bullets, consisting of 4 parts lead and one of antimony. This requires practically 4·908 lb. lead and 1·217 lb. antimony per shell. In addition fine stibnite mixed with magnesium powder is used to produce the smoke that enables an observer to register the point at which the shrapnel bursts. This calls for 0·0238 lb. stibnite and 0·02322 lb. magnesium per shell. British 3·3 inch shrapnel uses even more lead, the total weight of the bullets being 7·92 lb. and the composition 7 parts lead to one of antimony. This shell also requires 4·04 lb. copper and 1·87 lb. spelter.

THE shareholders of the Consolidated Gold Fields of South Africa received a pleasant surprise when the announcement was made of a dividend at the rate of 7½% for the year ended June 30, for it was generally expected that depreciation of holdings would wipe out the profits received from subsidiary companies and other investments. During the last two years, £2,500,000 has been allowed for depreciation, and last year the probable effects of the war were anticipated by a particularly critical re-examination of the value of the assets and a corresponding writing down of holdings. Thus the present position owes its strength to the provisions made in advance. The meeting of shareholders takes place the day after the Magazine is published, and as the Chairman's speech usually contains additional interesting matter, we will postpone an analysis of the details until next month.

INTERESTING sidelights upon the mining industry are thrown by the reports of the great manufacturing companies which supply machinery. Thus the chairman of Fraser & Chalmers in his speech to his shareholders noted a decrease in the business of that particular firm in the war year in Australia and Canada, but an increase in South Africa. The agency that had been established in Russia was too new to afford any index on conditions there. The decrease in total tonnage seems to have been world-wide, but in South Africa the shortage due to withdrawal of German dealers was so great as to permit an actual increase in the sales of British companies. Speaking broadly, also, decreasing tonnage was compensated by higher sale prices, received for industrial and war material, though that does not necessarily mean profits, since costs have risen for manufacturers as well as miners. Stocks are undoubtedly low at many mines, and at the first assurance of peace we anticipate active buying of mining supplies as well as mining shares.

STUDIES of tin dressing are to be taken up by the Institution of Mining and Metallurgy under a government grant, and thus definite results have followed from the suggestion made at the Falmouth meeting of the Royal Cornwall Polytechnic Society. The work will be conducted under the immediate direction of a committee from the Council of the Institution, which has made a grant in its support. This is to be supplemented by funds collected in Cornwall through the agency of the Polytechnic, and application for a further grant has been made to the Privy Council. In view of the importance and definite character of the researches proposed, there is little doubt that this will be authorized. The plan contemplates co-ordinate work in the Bessemer and other laboratories of the Royal School of Mines, in tin-dressing plants in Cornwall, and in private laboratories. It will bring together and test the results of much research already accomplished, and it is well calculated to yield definite results, not only as regards tin, but tungsten and associated rare metals. We are delighted at seeing the work begun, and we believe it to be an eminently proper field for public expenditure. The rest of the world has all too long allowed Germany to monopolize the benefit of stimulating technology by government support.

STANDARDIZATION is a project dear to us and we are glad to present this month the essential part of a preliminary report on the subject made to the Mining and Metallurgical Society of America by a committee consisting of Messrs. C. R. Corning, J. Parke Channing and George C. Stone. Such men could not write upon a subject without being helpful, and we are sure our readers will find much of interest in the report. The committee has in mind consideration of additional topics already studied by the Institution of Mining and Metallurgy and the Bureau of Standards with the evident earnest purpose to agree as far as possible with results already reached by others. The members will, we are sure, welcome criticism and comment whether by members of the Society or others interested. Our own present contribution to the subject takes the form of a discussion of weights and measures, which we trust may prove helpful.

DISCUSSION of the new by-laws of the Institution of Mining and Metallurgy at the meeting held on October 21 was not extensive, but was on the whole informing. Mr. E. P. Rathbone and Mr. Stephen Lett, on behalf of a friendly opposition, questioned the administration, and for the latter the President, Sir T. Kirke Rose, answered informingly and in excellent spirit. It appears that in fact, though not by rule, the members of the council are held to a strict standard as regards attendance. For this the President vouched, and offered as evidence the fact of his own failure of re-nomination at a time when he had been remiss. It was also brought out that suggestions as to nominations, if made in time to the secretary, received careful attention, and that in any event it was easy for members desiring to honour some fellow member to see that his claims were given due consideration. Other points were satisfactorily disposed of, and the by-laws were then unanimously adopted. Probably it is even truer than we have suggested that in practice matters run more smoothly than one would be warranted in anticipating from any study of the size and method of choosing the council. They would probably run even more smoothly if more advantage were taken of such opportunities as occur to permit the members a glimpse into the council chamber and to inform them of the business of the Institution, which fundamentally is the business of its members, and of the problems their officers face. All like to feel that they have a real part in what is being accomplished.

COPPER producers in America have long been restive under market conditions. Controlling as they do the larger part of the production, they have had surprisingly little to say as to the price, and especially the terms upon which copper should be sold. In considerable part this has been the result of the American law which prevented any effective combination of producers. A more important factor was the need for all the capital and energy available in producing the copper, and the feeling that it was just as well to let someone else worry with the markets. The Guggenheim interests, for example, have sold through others, and as a general rule have let their metal go as it was made. Now there is a general determination to sell hereafter on a dollar basis and, so far as may be, to make New York the chief market. The Guggenheim output has been rapidly growing, and with the Chuquicamata copper to care for in addition, it is necessary for the companies concerned to adopt a somewhat different attitude toward the market. One step in the programme was the opening of an independent selling agency in London this summer. This, we learn, is to be permanently maintained, and the agency will be expanded. It forms part of a general plan for bringing producers and ultimate consumers into more direct contact, which should make for economy all round. There is an enormous amount of good work still to be done in the way of study of the economic uses of the various metals, the markets for nearly all of which could be broadened by intelligent effort. As the producers and consumers get better acquainted such results should follow. Aside from that, eliminating the middleman is quite in the order of the day, especially when, as in the metal market, he is mainly German.

Extralateral Rights in an English Court.

Interest in the suit of the Amalgamated Properties of Rhodesia versus the Globe & Phœnix Gold Mining Company, now being heard in the Court of Chancery, is keen. The amount involved, some £400,000, the prominence of the men concerned directly or as expert witnesses, and most of all the fact that this is the first important suit involving the extralateral right which has come before this court, all contribute to this end. It is true that in form it is a suit for accounting under a contract and so in the eyes of the plaintiffs a mere matter of ordinary English law, but the defence is being argued as under Rhodesian law and rests essentially upon the extralateral right. The case was called on October 26, and from the opening arguments of opposing counsel and the testimony of the first witnesses called by the defence, it is possible to outline the main contentions of both parties. Briefly the plaintiffs claim accounting under a contract of sale of the John Bull claim to the Globe & Phœnix company, the terms of the sale having been that, in addition to a cash payment of £1000 received by the Amalgamated Properties, the latter "retained" a one-half interest in "all minerals" recovered from the John Bull claim. The John Bull lies to the dip of the Phœnix claim, from which the defendant company has worked downward along the vein and under the John Bull. Since the purchase that company has sunk a vertical shaft to these lower workings within the limits of the claim mentioned. The contention of the Globe & Phœnix company is that any ore that it may have taken from below the John Bull came from the Phœnix 'reef,' to which it has undisputed claim. It urges that under the Rhodesian law the Amalgamated Properties company owned, not the ground covered by the claim in the English sense, but only the right to work the John Bull or discovery reef, to register any secondary reef found within the claim, to occupy the surface for certain purposes, and to enjoy certain other rights and privileges not material to the question at issue. Under this construction the Amalgamated Properties had, at the time of the sale, no property in any vein or reef under the John Bull claim except the John Bull itself. Unless, therefore, the ore in question formed part of the John Bull reef, which does not seem to be claimed, and following the rule that a man cannot sell what he does not own, the prosecuting company would have no claim. It is urged that the word "retain" used in the contract indicates that the further payments related only to what the company already owned, and that the Amalgamated Properties company did not by virtue of the contract acquire any right or title to any part of the Phœnix 'reef,' which, the defendants claim, is the only reef being worked. As to this general argument, which would have placed the burden of proof on the prosecution, Mr. Justice Eve said briefly that he would not think of deciding so important a case without hearing all the evidence, and he therefore suggested that, without prejudice, the defendants show their proof of right to work under the John Bull claim. This they have proceeded to undertake through expert witnesses, Mr. C. B. Kingston being the first called. According to Mr. Kingston the Phœnix is a branching reef formed on and near the contact of an acid intrusive rock penetrating ancient schist. It is sometimes on one and again on the other side of the contact, and the outcrop, in a general way, follows that contact, particularly in a great curve or change of strike which may prove a significant feature. At the surface the vein occurs in two branches, which coalesce between the fourth and eighth levels, and in depth there is a third main branch; but he holds that it is all one reef, a trunk with numerous branches. It may be noted that this third branch is, seemingly, the one worked under the John Bull, and that, as shown by the models, it has a strike differing from the others and is not, apparently, known above certain lower levels. It offers an interesting field for speculation regarded as an unregistered blind lode, but until the experts of the plaintiffs present their interpretation, it is impossible to say what will be urged in answer to Mr. Kingston's explanation of the structure. From both legal and technical aspects the case bristles with problems, and at this stage we can only congratulate both parties on their good fortune in having to try their case before Mr. Justice Eve. He is not entirely unused to the vagaries of ore deposits, having presided in the case of a famous suit over mineral rights in china clay, and his keen interest and sureness of judgment afford pleasure to anyone familiar with the too often unsympathetic attitude of the big wigs who hand down justice from the bench.

Mexican Mining Law Changes.

In the course of the civil war that has been under way in Mexico, numerous changes in the previously admirable mining law of that country have been made or proposed to be made by various revolutionary chiefs. By the fortune of war, it now seems probable that only those emanating from the Carranza headquarters are to have permanent effect. We present elsewhere a summary of the more important modifications as they relate to metal mines, being indebted for it to the *Engineering and Mining Journal.* While joining the *Journal* in the fear that these decrees will somewhat retard the rehabilitation of the Mexican mining industry, we are not able to see the future quite as black as it appears for the moment to our usually happy contemporary. There are two main features in the changes now announced. The first is the requirement that taxes shall be paid in "National gold or its equivalent in silver," and the second is in the amount of the tax, especially on unimproved property. The first requirement was announced some time since. While, owing to the depreciation of Mexican currency, this is nominally a ten-fold increase in taxes, actually it leaves matters about where they were before the war. It merely prevents mining companies from making a profit, so far as taxes are concerned, out of the depreciation. The Mexican is not the first government that has refused to receive its own paper money. It is not cricket, but unfortunately it is common. It is to be remembered that the companies affected mainly mine gold and silver, and especially the latter. This requirement amounts to the Government maintaining its aliquot part in the output. Nothing would have been thought of it if the tax had originally been stated as a percentage royalty. Also, as to the requirement of gold, "or equivalent in silver," it must be remembered that the Mexican peso is not the American dollar. Persistent confusion of thought arises from the use of the word 'dollar' instead of 'peso,' when speaking of Mexican currency. A Mexican silver dollar contains just about the amount of silver that it is usually worth as bullion, and not, as in the United States, half that amount. The ratio being fixed by law the companies will therefore need to pay, not two ounces, but one (roughly) for each 'dollar' in taxes. The mining companies have suffered many and severe losses as a result of the war, but the depreciation of Mexican currency has operated to save them part of this since the increase in wages has not, generally, equalled this depreciation. Probably this margin will be reduced even if it does not disappear altogether in time. In fact certain decrees as to labour, such as the requirement of three months notice or three months pay before discharging a man, may prove to be more serious than the refusal to accept paper money in payment of taxes. As we have indicated, the latter really leaves matters much as they were, though it prevents the companies from recouping losses when paying taxes.

As to the increase in the taxes themselves, this much may be said. The losses of the war must be paid and it is inevitable that the mining industry, which represents a considerable portion of what may be spoken of as the 'active' wealth of the country, should not escape paying its full share. This happens to fall heavily upon aliens, because the Mexicans have usually preferred cash in hand to the profits of a continuing industry. The actual increases so far announced amount roughly to a multiplication by three for gold and silver. For copper the tax will be about $\frac{3}{4}$d. per pound of metal and for lead and zinc approximately $\frac{1}{16}$d. This is enough and it will affect the copper companies especially. Still the total of the tax is small as compared with that paid by him who would use London money in mining in certain parts of the British Empire, though Mexican taxes being assessed on gross output weigh heavier than those in the Transvaal, which lie against profits. We have no great faith in the superior wisdom of Carranza's advisers in finance, no Limantour has yet been disclosed, and there will probably be local and temporary injustice in allocating new taxes. But we might as well face the fact that mining in Mexico will hereafter be more heavily taxed. There is another important phase of the new tax system, that which reveals a deliberate effort to break up large holdings of mineral lands. This is to be done by means of a graduated tax increasing with the number of pertenencias held. This is quite in accord with the announced programme of the Maderistas, to divide the land among the people. We believe that in essence the programme is sound, and we also think highly of the dictum that a miner should 'dig or get off the claim.' But it is possible here as elsewhere to push a good theory too far and real danger to mining may portend. The excess area tax begins, we believe, too low down the scale. Having regard to the requirements of modern mining, the companies that operate in Mexico must hold more ground than the allowable minimum. If the expense for doing so be made too heavy, large mining operations will not be undertaken. In the light of recent experiences, even stronger companies than heretofore will be needed for mining in Mexico and they will require areas commensurate to the capital involved. Just how the new decree will operate cannot be foretold. Much will depend upon the speed with which the country is pacified and the promptness with which normal conduct of business becomes possible. Mexico is a land of great mineral wealth. It has a hardy and industrious people who, rightly led, are capable of great things. If Carranza can bring to it peace and security, the mining companies can afford to pay and will willingly pay taxes even somewhat heavier than in pre-war days. That the mines in

Mexico are rich is conclusively proved by the fact that some have made profits even under the conditions of the past few years. Given peace and the opportunity to work, the experienced groups will make profits for their shareholders under any reasonable scale of taxation.

Spassky and Atbasar.

Last month we reviewed the year's work at the Kyshtim mine, following a similar statement covering recent results at the Sissert. This month we take for our text two more of the mines at which foundations for a great Russian copper industry are being laid, the Spassky and the Atbasar, both nowadays owned by the Spassky Copper Mine Limited. The Spassky is in the Akmolinsk district of Siberia and, including coalfields, mill sites, and other properties, an area of about 100 square miles is controlled. In this there are the Yuspenssky copper mine, the Karagandy colliery, the Spassky smelter, the Sary Su concentrator (building), and various offices and quarters. These are connected by a local railroad, 26 miles long, owned by the company, but transportation between the estate and the Trans-Siberian at Petropavlovsk, roughly 500 miles, is by post road. The Yuspenssky is an old mine famous for a large production of high-grade copper ore, the recent average being about 26%, with a small content of gold and silver. The company has been mining this ore and smelting in small blast-furnaces, necessarily expensive but fortunately profitable work. Some time since it was recognized that this could not continue, as the shoots of high-grade ore decreased in size with depth, and the officials faced the problem of the future of the company. Two lines of attack were followed. The ore at the Yuspenssky occurs along a contact between 'porphyry' and schist. While the geology of the estate has been studied by Dr. J. Mackintosh Bell, his report has not been printed, so that one can speak only in general terms. The high-grade ore seems to have represented secondary enrichment along the hanging wall of a part only of a large mass of sulphides, including bornite and chalcopyrite especially, which fades off into the foot-wall. This low-grade ore extends beyond the high grade both on strike and dip and, as stated, into the foot-wall an indefinite distance measured by the limit of workability. Speaking in general terms these bodies are 70 to 80 ft. wide. As will be readily understood they were already in large part developed. In the report for 1914 just issued, Mr. Herbert C. Woolmer estimates the amount of this second-class ore at 346,917 tons averaging 7% copper and 16,589 averaging 9%. There is also 26,183 tons left of the first-class ore. There may be more; indeed, as we indicated in July, development since the close of the year has proved these figures to be conservative, but it was clear that either new shoots of high-grade ore must be found or plans perfected for working the ore previously left in the mine. The contact along which the Yuspenssky orebody occurs runs a long distance through Spassky ground and it would seem reasonable to hope, as proved true at the Sissert, that vigorous prospecting along it would bring to light more orebodies. This is, however, a slow process and little has been done. Perhaps it would be fair criticism to point out that an earlier start in this direction would have been warranted. As to working the low-grade ore, preparations were made at once. Mr. W. G. Perkins outlined a new smelting scheme, with reverberatories to handle flotation concentrate and a larger blast-furnace for direct ore, and which, by obviating the need for an expensive flux required by the barium sulphate in the crude ore, would permit the making of copper almost as cheaply as under old conditions. This scheme was adopted and a vigorous building programme was under way when the war opened. Still earlier, while searching for other ore, the company acquired the Atbasar and by close drilling it has developed 543,900 tons of ore averaging about 9% copper, of which 150,400 tons assays 13%. To make this available it is necessary to build mining and smelting works, open a coal mine, and connect the various units with a railroad involving about 75 miles of line. Here again the opening of the war found an active building programme in progress. The war called away men from both mines, interrupted transportation, raised the cost of supplies, and delayed the work. In the meantime the high-grade ore at Spassky was decreasing rapidly, the output in the first six months of 1914 even before the war, being materially below that for the corresponding period of the year before. In discussing these matters in July we expressed the hope that Treasury officials here would see the need of allowing the Atbasar to raise new capital. We learn with regret that they did not do so, and that therefore both companies have had to depend for expansion on current profits and the existing balance. This fact in turn, together with the absolute impossibility of securing materials such as rails, has made it necessary for the engineers to resort to numerous ingenious but expensive expedients, such as taking the machinery for the Atbasar in from the main line by means of a railroad, of which the rails are torn up after the train passes and relaid in front. The train occupies $1\frac{1}{2}$ miles of line, carries a load of about 3000 tons, and the amount of rail available allows of a line about nine miles long. So far as we know, this is the most ambitious undertaking of the sort a mining man has been called upon to accomplish. It will serve to illustrate the nature of the difficulties that engineers have had to face in Russia this year. Mr. E. T. McCarthy, consulting engineer for the company, is now visiting the properties, and we trust that he may have good news for the shareholders on his return. In the meantime we urge patience. Both Spassky and Atbasar are properties of large intrinsic value, as yet imperfectly developed, and should in time yield ample reward to those who refuse to be discouraged by the temporary coincidence of a change from high to low-grade ore, and a great war.

Waihi Geological Problem.

On various prior occasions we have discussed the geology at Waihi and we assume that by now our readers are fairly familiar with the main facts and, in particular, with the structure as made out and the interpretations as given to it by Dr. J. M. Bell and Mr. Colin Fraser in the report made to the New Zealand Geological Survey. In a paper presented last month to the Institution of Mining and Metallurgy, Mr. Arthur Jarman has questioned this interpretation as regards certain vital points. The main facts will be found in our Précis on another page. It may be worth while to consider here how such conflict of opinion can arise between competent geologists, and whether there is some middle ground that can be rightly occupied. Stated in briefest form, Messrs. Bell and Fraser considered the productive orebodies to be distinctly related to a certain part only of the great dacite mass in which the veins occur. They suggested that this part of the dacite is younger and intrusive into the main flow or series of flows. Reading different portions of their reports it is not entirely clear just how far the authors meant this interpretation to be regarded as a working hypothesis and how far a final conclusion, but it has been generally accepted as a true explanation. Mr. Jarman, geologist for the Waihi Grand Junction company, attempting to map the boundary between the two, found no certain line, and reviewing all the evidence came to the conclusion that there was no such difference between the various parts of the dacite, which accordingly he holds to be one body of extrusive rock. The economic importance of the matter makes it one of large interest, since its determination controls the direction for prospecting. As to that Mr. Jarman seems to have the better of the argument since, following his hypothesis, orebodies have been found in the outer or 'bedded' dacite. This is not conclusive, but it is suggestive. In general he challenges the evidence of the intrusive character of the central dacite, as being mainly negative and inconclusive. He further points to the presence of flow structure in the supposed intrusive rock, and the concordance of this structure with that in the admittedly bedded surrounding dacite, as proving that the whole constitutes one extrusive mass. That such sharp differences of opinion should exist may surprise the layman, but in fact they have not been uncommon among students of the type of ore deposits to which that at Waihi belongs. Perhaps the case most nearly on all fours with the present was that of the Tonopah orebodies. These, as at Waihi, occur in a series of bedded igneous rocks of Tertiary age. Mr.

J. E. Spurr, studying the district for the United States Geological Survey, concluded, as did Messrs. Bell and Fraser, studying the Waihi district for the New Zealand Geological Survey, that among the true flows was at least one intrusive (the 'Early Andesite'), and that the ores were not only genetically related to, but largely confined in, it. Mr. Burgess, occupying a position with the Tonopah Mining Company similar to that held by Mr. Jarman with the Waihi Grand Junction, became convinced that there was no intrusive but instead a normal sequence of extrusive rocks. So conclusive did his evidence seem to be that Mr. Spurr, returning to re-examine the district for the mining companies jointly, was quite prepared, as he has told in his report, to find his conclusions founded on studies made when the district was young and the mines shallow, wrong in part, and Mr. Burgess essentially right. A long and careful re-study, however, led to the surprising result that, while his earlier determinations required revision in part, as to the essential point they were confirmed. The apparent series of lava flows were only in part flows and in part they were sheet-like laccoliths representing younger intrusive rocks. In fact the oldest rocks, of four in question, chanced to be at the top and the youngest at the bottom. This suggests a possible explanation of the differences of opinion between Messrs. Bell and Jarman as to the facts and the interpretation at Waihi. It would seem possible, at least, that intrusive dacite as well as extrusive flows occur, and that the intrusive took the form, not of a stock, but of one or more laccolithic sheets between the flows. If this be indeed the true explanation, it would be quite possible that the flow structure should be found in all parts, geographically, of the area mined and that there should be a general conformity of the beds. It would even be possible that true coaly beds should be found between flows in the heart of the formerly suggested intrusive area, and there still be, at some level or levels above or below, truly intrusive rock. So far as we know this hypothesis has not been considered and we venture therefore to suggest it. There are many other most interesting problems suggested by a reading of Mr. Jarman's paper and re-reading of that by Messrs. Bell and Fraser. Their large scientific and economic importance leads us to hope that the Waihi Grand Junction management will continue to support Mr. Jarman's geological studies. He has already demonstrated their value by largely increasing the area which it is evidently worth while to prospect, and he has shown himself to be one who refuses to be bound by any current hypothesis, however convincing it may appear on first glance, so that we feel sure that he will approach the matters still awaiting solution with entire openness of mind. The practical value of the work so far done has been already suggested, and we trust this may prove an incentive to other great mining companies to look beyond the stoping for the current month and employ competent geologists to study their deposits in their broader aspects. It is better to look upon a deposit as a whole, than later to look at the mine as a mere hole.

Standard Screens.

At the present time, American mining engineers and metallurgists are keenly discussing the standardization of technical terms. Elsewhere we refer to the preliminary report by the Mining and Metallurgical Society, in which the proposals of the Institution of Mining and Metallurgy are carefully examined. We also reprint in our Précis a paper presented to the American Institute of Mining Engineers containing the suggestions of a sub-committee with regard to crushing tests and the nature of the screens employed in such investigations. The section of that paper devoted to recommendations with regard to sizing screens is of particular interest, and the principles involved in the construction of the proposed standard set serve to attract attention once more to the general subject of screens and their design. The preliminary report of the Mining and Metallurgical Society contains similar recommendations to those forming the subject of the paper presented to the Institute, and it is right to assume therefore that mining men in America are practically unanimous in their views on the subject. The two societies are to be congratulated on their emancipation from the slavery of the old idea that the width of the hole had to be the same as the diameter of the wire. The Institution of Mining and Metallurgy, the Mines Trials Committee of the Witwatersrand, and even Mr. Theodore Hoover designed their series of screens on that basis. The reason for its adoption was that the relation between the number of holes per linear inch to the width of the hole is by its means easily deducible. But against the convenience thus gained many disadvantages arise. For one thing the effective area of the screen is only 25%, that is to say the holes occupy only a quarter of the total area. Under such conditions the time occupied in the sizing operation is obviously longer than if the wires were proportionally narrower. Not only is time lost, but the necessary continued sieving action is apt to grind the particles still further, and so to give an incorrect result. A second objection lies in the fact that with wide wires the depth of the hole is unduly great and offers more opportunity for particles to jam and clog the screen. For both these reasons the wires are subjected to a greater amount of wear, and they must be replaced oftener in order that the apertures shall not become too big. Moreover, the closer the wires the greater the degree of crimping required, and the greater variation in the shape of the hole when seen from different angles. From all these points of view it is clear that the finer the wire the better, and the limit of fineness depends on the strength of the metal used in their construction. The actual design of a series of screens based on this principle must necessarily be left in the hands of an expert in screen-manufacture. Fortunately the American Institute and the Society were relieved of anxiety in this direction by the fact that a firm, the W. S. Tyler Company, of Cleveland, Ohio, already makes a screen of this type.

The other principle adopted by the American Institute and Society was that the ratio between the sizes of the holes of consecutive members of the series of screens should be uniform. The Rittinger ratio was considered to afford as many screens as are usually required in mining and metallurgical practice. With this ratio the area of the holes of each screen is double those of the preceding one. The basis of the committee's series is a screen having 200 holes to the inch, each 0·0029 in. wide, with wires 0·0021 in. in diameter. The area of such a hole is 0·00000841 sq. in., and the areas of the holes of the succeeding screens are obtained by successively multiplying by 2. The ratio of the widths of the successive holes is $\sqrt{2}$, or 1·4142. This series of apertures has the support of the United States Bureau of Standards, which adopted it after consultation with several of the big mining companies. To Mr. A. S. Disbro, of the W. S. Tyler Company, is due the credit of arranging the diameter of the wires and the number of holes per linear inch that would

Details of Proposed Screens.

Holes per inch	Width of hole. Inches.	Diameter of wire. Inches.	Area of holes. Inches.	Ratio diameter of wire to width of hole. %	Ratio of area of holes to unit of screen area. %
3	0·263	0·070	0·069	26	62
4	0·185	0·065	0·034	35	54
6	0·131	0·036	0·017	27	61
8	0·093	0·032	0·0086	34	50
10	0·065	0·035	0·0042	55	42
14	0·046	0·025	0·0021	54	39
20	0 0328	0·0172	0·00108	52	43
28	0·0232	0·0125	0·00054	54	42
35	0 0164	0·0122	0·00027	74	32
48	0·0116	0·0092	0·000135	79	31
65	0·0082	0·0072	0·0000672	88	28
100	0·0058	0·0042	0·0000336	72	33
150	0·0041	0·0026	0·0000168	63	37
200	0·0029	0·0021	0·0000084	72	33
Suggested Alternatives:					
40	0·0164	0·0086	0·00027	51	43
55	0·0116	0·0066	0·000135	57	40
75	0·0082	0·0051	0·0000672	63	38

correspond most conveniently to the series of apertures. In our Précis we give the table of figures relating to the screens, but we reproduce part of it above, with additional columns showing the ratios of the diameter of the wires to the width of the holes, and the effective area of the screens, that is the ratio of the total area of holes to the unit of screen area. These interpolated columns show that as the apertures grow larger the diameters of the wire become proportionately less, so that the effective screen area becomes greater. With the smallest holes it is found inadvisable to use very fine wires, as they would hardly be strong enough, and perhaps they would be difficult to crimp so as to hold in position; but the ratio of wire to hole diminishes as the mesh becomes coarser, and the effective screen area increases. There are, however, a few vagaries in the table, to which the attention of the two societies may be drawn. The wires used in the 35, 48, and 65 meshes are unnecessarily thick, and the effective screen area is accordingly diminished. If in these screens 40, 55, and 75 holes were made per inch, with of course the same width of aperture, a smaller wire would be required and the effective area brought more into line with the others, as given in the alternative three lines at the bottom of the table. In the 10 mesh and 14 mesh also, wires are employed that are thicker than called for, but of course 10 is a figure whose usefulness cannot be ignored. In connection with the table it would be desirable to recalculate the figures giving the areas and apertures, carrying the figures for the areas to eight places of decimals, beginning with 0·00000841 instead of 0·0000084, and those for the width of the holes to four places of decimals. As the table stands, cumulative errors may readily arise in calculations. With the more complete figures it would be easier to deduce the convenient diameters for the individual wires. In discussing the minutiæ of the construction of the screens much depends on whether the screens are intended for careful laboratory investigations or for the rough-and-tumble life of the average mill. In coarse-crushing machines screens are used, but in re-grinding and all-sliming such a method is inadvisable, and the operations of the machines are regulated by screen tests. Thus the members of a series of screens may have two different applications, and the overlapping of the two uses is not always easy to determine. For tests a thinner wire would be permissible, but in a machine more strength would be required, and a series of screens intended for both purposes would have to sacrifice a high ratio of effective area for greater strength of construction.

The advantages gained by having a series of screens with apertures the area of which increases in multiples of two are not clear. Rittinger adopted this system because he considered that the amount of energy expended in comminuting rock or ore was inversely proportional to the area of the holes through which they would pass. On the other hand Mr. Theodore Hoover holds that the energy expended is inversely as the size of the particles, so that according to the same plan the widths of the holes of successive screens should increase with the cube root of two, that is in the proportion of $\sqrt[3]{2} : 1$. Mr. Hoover's series contains a greater number of screens than the series based on the square root of two, and he urged that in experiments relating to flotation a closer classification was required than is possible on Rittinger's method. We confess that these scientific bases for a series of screens do not appeal to us strongly, for sizing is only a convention and not an exact science. For instance, the aperture is a square, and the mesh is calculated on its width, but particles of larger size pass through on the diagonal. As regards the size being a measure of the work done, we have to remember that the shape of the particles varies in every possible way, and that the constituents of a rock behave differently in the crushing apparatus. When the valuable part and the gangue crush to entirely different shapes, in needles, flakes, or cubes, the sizing results will not always give a true interpretation of the nature of the ore. Also the sizing of heavy sulphide and light gangue by means of screens does not give the ideal separation for purposes of concentration or metallurgical treatment, and in this connection a combination of sizing by screen and classifying by settlement as exemplified by Professor G. H. Stanley's apparatus deserves attention. But when working with screens alone we do not see that any ratio of theoretical interest is any more helpful than a ratio based on linear measurement. However, it is not desirable on this occasion to enlarge on the theory of work done, or to join in the Kick-Rittinger discussion. The question of ratio is as nothing compared with that of the proportionately wider aperture. We recognize the great value of the series of screens using as large an effective area as possible, and for this reason the proposed American standards deserve the most friendly considerations.

CONDITIONS OF DEPOSITION OF THE WITWATERSRAND SYSTEM*

By E. T. MELLOR.

The Upper Witwatersrand system is a great thickness, 9000 ft., of quartzites and conglomerates conveniently divided into two parts by the Kimberley shales. The most important of the auriferous conglomerates are the Main Reef, South Reef and the Main Reef Leader, the last named being dominant in the Far East Rand. In the interest of clearness certain changes in nomenclature are proposed. The rocks are interpreted as delta deposits in which the gold-bearing conglomerates represent episodes of flood. Compared with modern deltas the Rand is not too large or extensive to be out of scale. Mr. Mellor's conclusions are the result of an official geological survey covering the whole of the area discussed.

IT may be necessary briefly to indicate exactly what is meant in the present paper by the Upper Witwatersrand system. It has been generally customary to place the dividing line between the upper and lower divisions of the system at the horizon of the Main Reef. There are, however, many reasons why this line of division, which has arisen mainly from mining usage, is not a very satisfactory one. A much more natural method is to place the division between the upper and lower portions of the Witwatersrand system at the base of the series of quartzites which includes the Main Reef horizon, that is, along the line of junction of those quartzites with the big series of finer-grained beds below them (Jeppestown series). This series comprises a large proportion of slaty rocks, and falls naturally into the lower division, throughout which such slaty members are conspicuously developed. This line of division is not only a more natural one, but has the practical advantage, from the point of view of the field geologist and the mining engineer, of being much more likely to be recognizable in districts remote from the Rand, where it may be advisable to apply the same classification. It divides the whole system into two portions, in the lower of which argillaceous beds frequently recur and are the dominating type, while the upper consists almost entirely of coarse quartzitic beds and conglomerates with only one notable group of argillaceous type, the Kimberley shales.

If a brief review be taken of the Upper Witwatersrand section, it will be seen to consist of a continuous succession of coarse grained sedimentary beds some 9000 ft. in thickness, interrupted only by the Kimberley shales, which divide it into two main subdivisions. At several horizons in this succession of coarse sedimentary deposits there occur conspicuous groups of conglomerates. On account of their actual or possible importance from a mining point of view, the conglomerates alone, among the coarser sedimentary beds, have received any distinctive names, the intermediate quartzites, which form a much larger proportion of the whole, remaining without any distinguishing appellation. This leads to very indefinite grouping of the members of the system, as may be seen for instance by reference to current statements of sections similar to those given by Hatch and Corstorphine,† in which there appear certain definite 'series,' limited mainly to conglomerates and separated by large groups of beds which have no well defined place in the classification.

The difficulty arises from the fact that current nomenclature has been gradually evolved from mining usage. Such a term as 'Main Reef Series,' perhaps the most frequently used term in Rand geology and understood by everyone on the Rand, is a particularly unfortunate example of local nomenclature. The 'reef' is not a reef in the ordinary mining sense, and the word 'series' is employed to denote something quite different from what it would suggest to any ordinary geological reader. Thus when applied to the small group of conglomerate beds known as the 'Main Reef Series,' it frequently denotes a thickness of beds not exceeding 20 ft., as, for example, in the East Rand. On the other hand it has been applied to include so large a succession of strata as the whole of the Lower Witwatersrand system, which may be 15,000 ft. in thickness, as, for example, in the 'Hospital Hill Series' of Molengraaff, who also uses the term 'series' in the restricted sense above mentioned. The use of the same term for groups of beds of such very widely different orders is very inconvenient for many reasons, and especially when any detailed mapping or classification is attempted. It is probably too late to attempt to remedy many of the irregularities of Rand nomenclature. Something,

* From advanced proofs of an article on 'The Upper Witwatersrand System' read before the Geological Society of South Africa and communicated by permission of the Honourable the Minister of Mines and Industries.

† *Geology of South Africa*, 1909, pp. 133, 134.

however, might be done to bring the use of important geological terms like the word 'series' more into line with accepted usage for other systems of rocks in this country, and by geologists generally in other parts of the world. To limit the use of the term to the groups of conglomerates, as is at present the custom, seems quite illogical. The intervening quartzites are in many instances larger groups of beds, and should also, to be consistent, be termed 'series,' thus introducing needless complexity. Simplicity is perhaps the first virtue in classification, and the simplest way to avoid the present anomalies would seem to be to speak of the various groups of conglomerates simply as 'Elsburg Reefs,' 'Kimberley Reefs,' 'Bird Reefs,' etc., and to reserve the word series for larger subdivisions of the system.

A glance at sections of the Upper Witwatersrand system suggests that the formation in question falls very naturally into two groups of quartzites and conglomerates separated by the Kimberley slates, and this suggestion is in agreement with experience in the field. Although it is a point to which I have devoted special attention in mapping over the whole length of the Rand, I have never been able to find any well marked horizons which could be used for subdividing these larger divisions satisfactorily, and this is also most probably the reason why hitherto the conglomerate groups alone have received special names and why no attempt has been made to classify the intervening quartzites, in some cases thousands of feet in thickness. Theoretical divisions which cannot be applied to work in the field, to borehole records, or in any other definite way, can scarcely be justified. It would seem best therefore to dignify as series only the two main groups of quartzites and conglomerates into which the Upper Witwatersrand system naturally falls. In order to disturb existing names as little as possible, these two series might be termed respectively the Main-Bird series and the Kimberley-Elsburg series. The combination of such familiar terms as Main and Bird in Main-Bird series will probably obviate any danger of the 'series' being taken to apply to 'reefs' alone, since it would scarcely occur to anyone to combine the widely separated Main and Bird 'reefs' into a single series without including the intervening quartzites and other associated beds.

In accordance with long established custom on the Rand, the Kimberley shales were no doubt originally named with reference to the 'reefs' next above them. To avoid confusion this necessitates their inclusion in the Kimberley-Elsburg series, although otherwise they would have been associated more naturally with the quartzites below them.

In dropping the use of the word 'series' in connection with the various groups of 'reefs,' and using simply the terms 'Elsburg Reefs,' 'Bird Reefs,' and so on, a difficulty arises in connection with the Main Reef and its associates (commonly called the 'Main Reef Series'). The particular conglomerate horizon known as the 'Main Reef,' and still more its associates, the 'Main Reef Leader' and the 'South Reef,' certainly possess well marked characteristics which clearly distinguish them as individuals. Moreover, it would be entirely opposed to local usage to suggest any such thing as a plurality of 'Main Reefs.' The simplest way to avoid perpetuating the misleading use of the word 'series' in this connection, and one which would be in sufficiently close agreement with ordinary geological usage, would be to substitute the term 'Main Reef Zone,' a course which will be followed in this and in a subsequent paper on the East Rand. Where it is desired to refer particularly to the 'reefs' alone to the exclusion of the quartzites or other beds which accompany them, a sense in which the words 'Main Reef Series' are frequently used, such a term as 'Main Reef Group' might be used if considered necessary.

Consideration of various sections will show that the Upper Witwatersrand system presents a succession of quartzites, grits, and conglomerates, interrupted only by a single group of beds of finer material, the Kimberley shales, which divide it into two main divisions.

The most strongly developed of the conglomerates which constitute the economically important 'reefs' of the Witwatersrand is that known as the 'Main Reef,' which gives its name to the whole group. Closely associated with the Main Reef, yet having probably a still more distinct individuality, is a second band of conglomerate known as the 'Main Reef Leader.' In the Central Rand the Leader may lie directly upon the Main Reef, but east of the centre of Johannesburg, from the neighbourhood of, say, the Robinson mine, the two 'reefs' are usually separated by a greater or less thickness of intervening beds, which may be entirely quartzitic in character, but which very generally include or may be entirely made up of, 'slaty' material. This slaty member is most generally known in the mines as the 'Black Bar,' but is also referred to by other names, such as 'Slate

Leader' and 'Interbedded Dyke.' The Main Reef and Main Reef Leader together constitute a horizon which is persistent throughout the whole Rand, although these members are not necessarily both present throughout that area.

In the Main Reef perhaps the most characteristic features are the uniform average size of the pebbles, with frequently a preponderance of conspicuous white pebbles of coarse vein quartz; the absence of any well marked grading in size of pebbles, and especially the occurrence of the largest pebbles indifferently throughout the thickness of the reef; the frequent occurrence of partings or lenticles of quartzite or more sparsely-pebbled material separating the reef locally into two or more bands, and the absence of a very sharply defined and persistent foot and hanging wall parting. The gold values, too, have a limited range of variation and higher values are not characteristic of any special portion of the reef. On the other hand, the Main Reef Leader very commonly shows a considerable range in the size of pebbles in any particular section, accompanied very frequently, and in some parts of the Rand almost invariably, by a graded arrangement, so that the largest pebbles lie on, or in the immediate neighbourhood of, the foot of the reef, while the smallest are very generally found near the top. The foot of the reef is generally sharply defined and is marked by a characteristic and persistent 'foot-wall parting,' which is in many cases accentuated by the fact that the largest pebbles lie directly upon a bed of fine grained quartzite, 'slate,' or other material which is in strong contrast to the reef itself. The line of larger pebbles along the foot is often persistent even when the whole reef is reduced to a thickness of two or three inches or to a single layer of pebbles. Similarly the gold contents of the Main Reef Leader frequently show a strong tendency to concentration along certain lines, the actual foot of the reef being the most generally favoured, the larger pebbles on that horizon being not infrequently associated with 'visible' gold and extraordinarily high individual assays.

A description of the Upper Witwatersrand system, however brief, can scarcely be regarded as complete without reference to certain characteristics shown by some of its most important members which appear to throw considerable light on the conditions under which not only these beds but the whole of the Witwatersrand system was laid down. In the Central Rand, although individual conglomerate horizons can be followed for great distances along or near the outcrop, they are not open to investigation to anything like the same extent on the dip of the formation, since its inclination is sufficiently steep to carry them beyond the range of mining operations at a few thousand feet from the surface. In the East Rand, however, the disposition of the formation in a broad and shallow syncline which has been extensively explored by means of a great number of boreholes, followed by the sinking of numerous shafts and by other mining operations, allows of the various groups of beds being followed for many miles in various directions, independently of outcrops. The information obtainable from these sources has established, beyond reasonable doubt, the practical continuity of the horizon of the Main Reef Leader over the whole of the far Eastern Rand, not only in an east and west direction, but also toward the south as far as and beyond the neighbourhood of the Nigel mine.

In the Nigel mine the Main Reef Leader, known locally as the 'Nigel Reef,' exhibits certain features which it is very interesting to compare with those shown by the same reef in other parts of the Eastern basin and on the Central Rand. As at the Van Ryn, on the northern margin of the Eastern Rand, and practically in all mines lying east of the Cason, the reef at the Nigel lies directly upon fine grained, usually more or less argillaceous beds generally spoken of as the characteristic 'slate foot-wall' of the Eastern Rand. The reef consists of a conglomerate entirely similar in general characters to those of the nearer portions of the Rand, and frequently presenting the usual characteristics of the Main Reef Leader of which it is a continuation. The most interesting feature of the reef in this locality is its distribution in a number of well defined patches, frequently spoken of as 'shoots,' separated from each other by areas from which the conglomerate is entirely absent and where consequently the quartzites which normally form the hanging wall of the reef, lie directly on the foot-wall of 'slate.' Owing to the fact that the Nigel mine has been working nearly thirty years and that the greater portion of the available 'reef' has been worked out, the information available as to the distribution of the conglomerate is very complete, and the areas originally occupied by 'reef' are indicated clearly by the extent and arrangement of the stopes in the mine plans, as shown in Fig. 2 (next page). The shaded areas in this plan practically represent in size, shape, and mode of distribution the original patches of conglomerate. It will be noted that the patches are all oriented in a similar way and that their long axes exhibit a close parallelism in a direction from a little north of northwest to a little south of southeast. A very similar mode of distribution is shown in the Brakpan mines by certain areas in which the 'reef' has

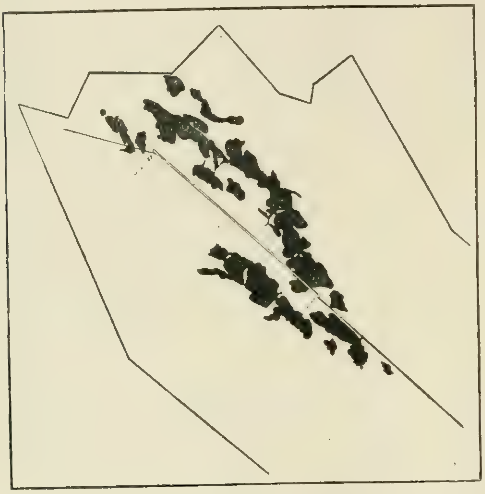


Fig. 1. Ore-Shoots at Brakpan.

These plans show the distribution of well-defined patches or shoots of conglomerate in the Far East Rand.

In Fig. 1, showing the ore-shoots at the Brakpan, the stoping represented by the dark areas coincides to a large extent with areas of reef distinguished by large pebbles, greater thickness, and better values than the surrounding ground. In Fig. 2 are represented the stopes in the Nigel mine, which correspond very closely with the original distribution of the conglomerate. The two plans are drawn on the same scale, and oriented alike. To occupy their true relative position they should be moved apart diagonally about 18 inches in directions parallel to the axes of the shoots. The scale of the plans is approximately 4000 ft. to the inch.

been found to be particularly well developed, and to be distinguished also by unusually good and consistent values. In this case the patches or 'shoots' are not separated from each other, as in the Nigel, by intermediate spaces from which conglomerate of any kind is entirely absent, although such conditions may be present in certain limited areas. The patches represent portions of the reef distinguished frequently by the greater thickness of the conglomerate and always by the larger average size of the pebbles as well as by a certain appearance of the matrix well known to and generally recognized by the mine officials. These features are accompanied almost invariably by specially good values. The intermediate areas between such special patches are also for the most part occupied by reef which is, however, characterized by the smaller size of the pebbles, much poorer values and, generally, by a less robust development. In Fig. 1 the approximate shape and extent of one of these areas is represented in plan, and it will be seen that it resembles in many respects those already noticed in the Nigel, and that the orientation of its longer axis is in almost exactly the same direction. On the northern margin of the East Rand syncline we have again in the Kleinfontein mine similar elongated patches of particularly good conglomerate characterized by pebbles much above the average, and correspondingly high gold values. In this case, as in Brakpan, the intermediate areas are also occupied by reef, which here, although not so good as that in the special areas, is for the most part well developed reef and of good value. In this case again the orientation of the long diameters of the special patches is in agreement with the two former examples. Similar instances might be quoted from other mines, but those already given will suffice to indicate the existence on the Eastern Rand of well marked patches, or 'shoots,' of reef possessing well-marked characters, and showing a general parallelism, with their long axes directed a little south of southeast. The three examples

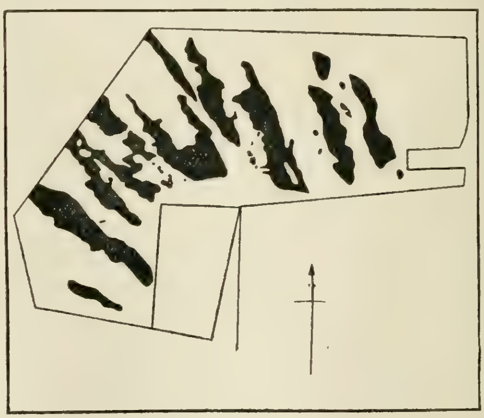


Fig. 2. Ore Shoots at Nigel.

quoted all lie practically along a straight line drawn from Kleinfontein to the Nigel parallel to the long axes of the patches. They also show a graduated falling off in the degree of development of the conglomerate from the robust conditions of Kleinfontein with its patches of specially large-pebbled reef in the midst of more ordinary material to the comparatively attenuated conditions of the Nigel with its completely isolated patches of thinner and smaller pebbled conglomerate.

Another remarkable feature which is observable in several of the more recently opened mines of the far Eastern Rand, and particularly noticeable, among others, in the Brakpan and Springs Mines, where some of the principal drifts present clean and continuous sections of the reef for thousands of feet in a direction approximately parallel to the long axes of the patches above referred to, is the wonderful regularity and persistency over long distances of the individual bands of larger or smaller pebbles which the reef usually shows. In the sedimentary deposit of this character one might expect to find frequent examples of false-bedding, and had the conglomerate bed been intermittently formed and its margin gradually pushed forward over the bed on which it was deposited, or had it suffered much reassortment and redistribution, it could scarcely have failed to afford frequent examples of false and irregular bedding. In the many thousands of feet which I have hitherto examined I have, however, met with no well marked instance of false bedding in the Leader itself.

The only explanation which would seem to account for this and many other features of the principal conglomerate bed of the far Eastern Rand is that it was laid down rapidly and practically continuously over the whole area. Personally I am strongly inclined to the opinion that the laying down of the Main Reef Leader of the Central Rand and its continuation as the principal conglomerate bed of the Far Eastern Rand was the result of a single geological episode, and that the time occupied in its deposition is to be reckoned by days rather than by those more liberal measures of time usually allowed to geological events. One of the most remarkable features of the principal conglomerate bed of the Eastern Rand is that it was laid down over many hundreds of square miles directly upon a wide sheet of muddy or very fine sandy material, which over the whole of that area formed the uppermost portion of a sequence of similar strata some hundreds of feet in thickness. That this abrupt change in the character of the sedimentation was probably brought about simultaneously over the whole area is to some extent shown by the considerations already alluded to. Among other further indications may be mentioned the fact that nowhere do we find evidence of that type of erosion of the underlying muddy deposits which might be looked for with the gradual extension of pebbly deposits over them. On the other hand, we do find evidence of such erosion as might be expected to occur with the rapid sweeping of the pebbly deposits over a previously existing expanse of hardened silt. Thus in the Kleinfontein mine I recently found numerous examples of the inclusion of fragments of the foot-wall in the overlying conglomerate, particularly its lower portion. One of these fragments was a foot in length and about two inches in thickness and of irregular tabular form with angular edges. It appeared to be one of many pieces of partly consolidated sediment which had been torn from the underlying muddy material and immediately included in the pebbly mass which had swept over it.

From a geological point of view, perhaps the most remarkable fact about the 'reef' in the Far East Rand is that a conglomerate bed of such great extent should have been laid down directly upon a considerable thickness of muddy or argillaceous beds, and this without any transitional phase. If the beds had been deposited in the reverse order, it would be very easy to imagine the conditions under which they were laid down, but the sudden change from a long continued deposition of fine sediments to a widespread conglomerate bed can, I think, only be satisfactorily explained under conditions approaching those of an extensive delta comparable to some of the largest of existing examples. In this connection it may be remembered that the Main Reef Leader is by no means the only example of such an abrupt change in sedimentation in the Witwatersrand system. In the lower division of that system an almost exactly similar case is that of the Government Reef, a single bed of conglomerate which rarely exceeds three feet and is usually only a few inches in thickness. Yet this conglomerate bed is practically continuous over a distance along the strike of at least forty miles, and most probably has a corresponding extension in the direction of the dip. It rests directly upon what were originally muddy and fine sandy sediments of the nature of deltaic silts with a usual thickness of about 500 ft., and is itself succeeded by some 500 ft. of grits and quartzites. Similarly in the Upper Witwatersrand system, the lowest conglomerate bed in the Kimberley Reefs over large areas in the Far Eastern Rand lies directly on the Kimberley 'shales,' another group of muddy and sandy sediments, or silts, 350 to 500 ft. thick.

But perhaps the most striking of such deposits which point to the sudden distribution of coarse material over an extensive area of fine grained sediments is the so-called 'speckled bed' of the Lower Witwatersrand system. This bed, an arkose or felspathic grit, overlies about 700 ft. of 'slates,' representing muddy and fine sandy sediments, and is succeeded by about the same thickness of similar beds. The grit thus forms a single sharply defined bed only three to six feet thick coming in the midst of a big succession of argillaceous sediments. In the course of the detailed mapping of the Lower Witwatersrand system, I have traced this bed along the outcrop over a distance of some 25 miles. From the fact that it shows no signs of any marked diminution in thickness at the points beyond which it becomes impossible to trace it, the bed probably extends much further than the known outcrop. It is difficult to imagine how such a bed could have been deposited except on the margin of an area of sedimentation similar to that of a very extensive delta, and as the result of an exceptional flood which carried coarse sediment into a wide area normally reached only by much finer material. Many similar instances of coarser beds being found within a long succession of fine grained deposits, and of their continuity over 50 miles or more, though themselves only a few feet in thickness, might be given. The occurrence of such beds led me in an earlier paper on the Witwatersrand system* to attribute their peculiar characters to deposition under conditions similar to those prevailing within, or around the margin of, an extensive deltaic area, and later to express the opinion that the same explanation may be extended to a large part of the Upper Witwatersrand system, including the Main Reef zone.†

The wide range in type of sediment, from fine argillaceous material to coarse conglomerates, and the frequent alternation of such finer and coarser types shows that either oscillations of level, or pauses in the prolonged period of subsidence which coincided with the deposition of the Witwatersrand system, frequently altered the relationship of the area now known as the Witwatersrand to the points of discharge of the sediments and to the actual delta which might have existed at any particular time. Speaking generally, the location of such points of discharge must have gradually approached the present Rand, so that, while during a large portion of the Lower Witwatersrand period this lay on the furthest margin of the area covered by the deposits, and therefore beyond the limits of any actual delta, toward the close of the Upper Witwatersrand period, and during the deposition of the Elsburg conglomerates, the coast line was not far distant from it. About the time of the deposition of the Main Reef zone and the immediately preceding beds, the conditions were probably such as exist within an actual delta. Thus, for example, if the deduction made above, that the Main Reef Leader represents a single rapidly deposited sheet of conglomerate, the surface which it covered up and preserved must have been extremely like that existing in many modern deltas, consisting of extensive areas of silt traversed by occasional deeply cut channels filled with extremely irregular deposits varying from mud to masses of coarse gravel. The beds underlying the Main Reef Leader on the Eastern Rand appear to have been entirely similar to modern deltaic silts, while the confused masses of coarse conglomerate, pebbly grits, and muddy material associated with the Black Bar, of which instances have been given above, and which appear to fill extensive and irregular channels cut in the underlying silts and sands, closely resemble similar deposits which fill channels existing in the deltas of today.

Since first beginning to consider the peculiar features of many members of the Witwatersrand system as due to widespread deltaic conditions, I have collected much evidence bearing on the subject. It has, however, been found that it is difficult to get very definite information concerning the constitution and history of existing deltas, and particularly with regard to the possible extent of any individual stratum of deposit. It may indeed happen that the evidence afforded by the Rand, from its exceptionally numerous boreholes and other mining explorations, may, especially as it grows more complete, add something to our knowledge of the constitution of deltas in general.

In connection with the deltaic origin of many of the striking features of Witwatersrand sedimentation, attention may be called to a few points which should not be lost sight of in considering the adequacy of such an explanation. First, with regard to the character

* 'The Normal Section of the Lower Witwatersrand System, etc.' *Trans. Geol. Soc. S.A.*, vol. xiv., 1911, p. 122.

† 'On the Mode of Deposition of the Auriferous Conglomerates of the Witwatersrand.' *Compte-rendu du Congres géologique international*, Toronto, 1913, pp. 895-900.

I find that a somewhat similar origin for the conglomerate beds as "a vast fluviatile formation or torrential deltas spread along alluvial plains like those of Lombardy" has been suggested by De Launay (*Les Richesse Minerales de l'Afrique*, Paris, 1903). Conditions more nearly approximating to those described above appear to be necessary to account for many peculiarities of the conglomerates as well as for other features of the Witwatersrand system to which reference has been made.

of the material, the greater number of the members of the Witwatersrand system are similar to deposits found in modern deltas, and in this connection should be noted the frequent recurrence of considerable thicknesses of alternating muddy and fine sandy sediments, as in the case of most of the so called 'shales' or 'slates' of the system, such as the Jeppestown beds and the Kimberley shales, which appear to be exactly of the same type as the silts of modern deltas. With regard to the extent of deposits like the Main Reef Leader, which it is suggested constitute practically individual beds, if the known extent of such a bed be plotted to scale on a plan of such a delta as that of the Ganges, it will be seen to occupy a comparatively small area. If, for example, we regard the Main Reef Leader as extending laterally from near Roodepoort on the west to a little beyond the present furthest eastern border of the Rand, a distance of some 45 miles, this would represent less than one-sixth of the distance across the front of the present delta of the Ganges (see Fig. 3). If the area of the deposit in question be compared with the total area occupied by the Ganges delta, and still more if compared with contiguous deltas like those of the Hoang-ho and Yang-tse-Kiang with a combined extent of 400 miles along the coast, it would appear insignificant; and it does not seem unreasonable to suppose that in times of exceptional floods an area as large as that covered by the Main Reef Leader might be simultaneously subjected to the action of a widespread current of a velocity sufficient to carry material similar to that of the Leader, since pebbles above the average size of those met with in that reef would only require a current of two miles per hour for their transportation. In 1893 I had the good fortune (from a geologist's point of view) of witnessing the course and effects of the exceptional floods which occurred in most of the rivers along the eastern coast of Australia. On the lower portion of the Macleay river, where my observations were made, we registered 25 inches of rain in three days, and the fall about the headwaters of the river was certainly greatly in excess of that amount. The river rose above all previous limits reached within the recollection of white men in that locality, and the effects produced were so different from, and so largely exceeded those of, ordinary floods as greatly to impress an observer with the potentialities of such unusual but not unique events. The nature and amount of the sediment carried out from a river at such a time must be far different from that normally discharged, and sediment of any particular degree of coarseness must be carried far beyond its ordinary limits of deposition. In a deltaic area, where such deposits would be likely to be protected against subsequent removal by marine or other agencies, they would be likely to remain as permanent records of the unusual events which gave rise to them. In such a way one can imagine that the invasion of large areas of pre-existing fine sediments by deposits comparable to the Main Reef Leader or the Government Reef of the Rand might arise. That events competent to produce such results occur in existing rivers can be readily shown

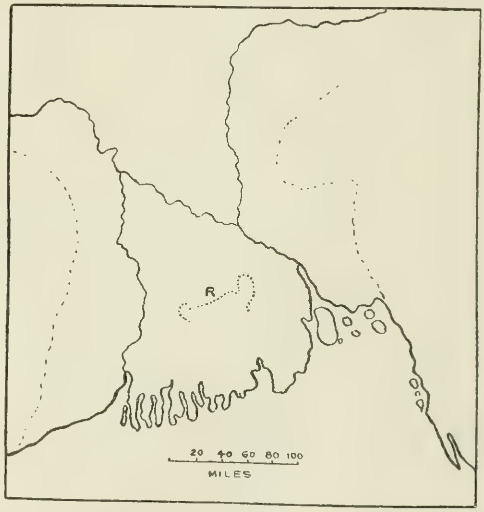


Fig. 3. The Ganges Delta, with the known extent on the outcrop of the Main Reef Zone shown on the same scale by the dotted line R.

by the reference to the Hoang-ho, which has frequently swept over immense areas in devastating floods, and incidentally shifted its mouth hundreds of miles from its previous position. In one instance, of which we have actual historic record, the return of the river approximately to its former course took place only after an interval of nearly 1700 years. It would not be surprising if the deposits accumulated opposite the alternative mouth during that interval should have been suddenly succeeded by sediments considerably different in character. If such changes occur at still larger intervals and be accompanied by changes of relative level in the adjacent areas, still more marked results might reasonably be expected to occur.

The explanation suggested above of the origin of such deposits as the Main Reef Leader might at first sight appear to involve transportation of material on a scale too vast and at a rate too rapid to be easily accepted. It must, however, be remembered that under the conditions suggested vast quantities of suitable material, already accumulated along the lower course of the river and in the upper portions of its delta, would be available, and would only require to be moved forward a comparatively short distance and to undergo a certain amount of rearrangement in order to bring about the observed conditions. The accumulation of such enormous quantities of well rounded pebbles, so uniform in type and in average size as are to be found in such reefs as those mentioned, must have been the work of long periods of time, but the redistribution of such material over a closely adjoining area in the manner in which we now find it may well have been the work of a very few days.

Since the subject became of particular interest in connection with the interpretation of certain features of Rand geology I have taken many opportunities of watching the evolution of miniature deltas such as are formed in large numbers as a consequence of the rapid transportation and redistribution of material accumulated during the dry season of the year and swept away by the earlier summer storms on the Rand. It has been extremely interesting to find features which appear in some earlier sketches of such miniature deltas, particularly with regard to the manner of distribution of the coarser pebbly material, reproduced in a most striking manner, but on a vastly larger scale, in the principal conglomerate bed of the Eastern Rand, as shown, for example, in the Nigel and other mines referred to. The shape, proportion of length to breadth, parallel orientation, and mutual relations of the patches of the conglomerate in the mines are closely reproduced by the patches of coarser sediment and small pebbles and rock fragments in the miniature deltas, and lend support to the other evidence for the deltaic origin of the conglomerates in question.

The absence of fossil evidence, as far as is known, from the older South African geological systems, prevents any close correlation as to age with those of other countries. Like several other South African formations, however, the Witwatersrand system in its general characters and geological relationships exhibits many points of resemblance to formations in other parts of the world, as, for example, to the Proterozoic or Algonkian rocks of North America. Among such points of resemblance may be mentioned the great thickness of quartzites; the occurrence of banded rocks, very rich in iron, some of which are exceedingly similar in appearance in both areas; the obscure occurrences of carbonaceous material in certain beds; the unconformable relationship between different divisions of the system in some localities with conformable or nearly conformable relationships in others; and the rarity or absence of fossils coupled with indications of the possible existence of life.

Among the formations by which the Witwatersrand rocks are succeeded the Transvaal system will bear comparison with the Cambrian, while the Waterberg system of South Africa exhibits many points of resemblance to the Old Red Sandstone of Europe. The more certain correlation of the rocks of the Karroo system, through their fossils, with the Permo-carboniferous of other countries brings us on to more certain ground and serves to some extent to countenance the comparisons made above, which, however speculative in character, are interesting as bearing on the general similarity in the sequence of formations found in widely separated parts of the world.

Uses of Platinum.

In a paper published by the United States Geological Survey on the production of platinum in 1914, James M. Hill reviews the present uses of the metal. One of the most important is as a catalyser in the manufacture of sulphuric acid. The catalyser is made by soaking a base of asbestos or magnesium sulphate in solutions containing platinum chloride and afterward applying heat whereby the metal is precipitated as very fine metallic particles throughout the mass. The loss of platinum in the contact process is negligible. Less platinum is used nowadays in the electrical and dental industries, nickel-chromium, tungsten, or molybdenum being used instead. The sparking plugs of gas engines nowadays have tungsten ignition points. Less platinum is now used in jewellery, partly because the fashion has changed, and partly because the art of platinum plating has been perfected. Mr. Hill is not able to give relative figures for the consumption of the metal under the various heads, and indeed there is great difficulty in obtaining reliable figures for the amounts marketed. During 1914 the imports of platinum into the United States, including ore, crude metal, and manufactured products, totalled 46,533 oz., while 3430 oz. was obtained from home sources. In addition 40,698 oz. of scrap was re-marketed, such product being known in America as 'secondary' platinum.

MINING IN TRENGGANU

By HENRY BRELICH.

On the eastern side of the Malay Peninsula the conditions have not been so favourable for mining as on the western side. This article describes work done in one of the eastern states.

TRENGGANU is situated on the east coast of the Malay Peninsula, bordered on the south by Pahang, and on the west by Kelantan. It has an area of about 6000 square miles, with a population roughly estimated at 200,000, distributed over the larger coastal villages. The interior is sparsely populated, and away from the navigable waterways there are vast stretches uninhabited. Formerly Siamese

Map of Malay Peninsula.
Showing the various States and political divisions.

territory, it was ceded, together with Kelantan, Kedah, and Perlis, to the British Government in 1909.

The development of the eastern coast of the peninsula, in particular the state of Trengganu, owing to the difficulty of access, its dense vegetation, and its mountainous nature, has not made much progress, whereas the more accessible western coast has been actively exploited for its mineral and agricultural wealth. However, since the cession of the state by Siam, greater activity has been noticeable, and as the comparatively shallow and easily worked alluvial deposits of tin in the western states become exhausted, and more complicated and costly methods for working the deeper deposits are required, the untiring Chinese prospector is turning his attention to this state.

While still nominally under Siamese rule, both lode and alluvial mining had been carried on for a number of years along the waterways or in the more accessible parts of the country, and, until recently, tin was the only mineral mined. It occurs as alluvial in many of the narrow creeks and tributaries of the larger rivers, and, so far as is known, in lodes or replacement deposits in the granite, only in the southern part of the state. While working for alluvial tin near the source of the river Jingah, a tributary of the Dungun river, and at the foot of the southern slope of an isolated mountain, Bukit Runtoh, the Chinese first discovered wolfram associated with the alluvial tin. At that time, 1907-1908, wolfram was not in great demand, its value was unknown to the Chinese, and the smelter refused to purchase or penalized the tin concentrates which contained wolfram. When the demand for this mineral in the East increased, and the Chinese who were working and prospecting for tin became aware of it, they turned their attention to the creeks and gullies along the southern slope of Bukit Runtoh, at the foot of which they had previously found tin and wolfram associated together. These were found to be rich in wolfram shed from the extraordinarily rich outcrops, which were subsequently discovered.

Topographically, Trengganu is a hilly country typical of the east coast, with no very extensive flats such as are to be seen in other parts of the peninsula. The coast line consists alternately of shallow beaches and rugged bluffs, which prevent the near approach of the coastal steamers, thus forming a natural barrier to the development of the state, which would be made easier if a suitable harbour open to navigation all the year round could be found. The rivers wind interminably along the flat patches at the foot of precipitous hills, flowing swiftly and full of sediment after a heavy rain, the sediment being deposited at the mouths of the rivers and effectually barring easy access. They are navigable throughout the year by means of shallow native boats or *prahu* having a carrying capacity of about three tons.

The principal geological formations consist of variously coloured clays, slate, schist, quartzite, granite, sandstone, and limestone. The dense vegetation and deep overburden render prospecting, away from the immediate vicinity of the waterways, extremely difficult, and it is only along the river banks and on the slopes and summits of some of the high mountains, which have withstood erosive action, that one is able to see and to examine rock exposures. The country has been subjected to considerable disturbance, and weathering influences have penetrated deeply into the ground through the faults and cracks resulting from the shattering of the country. Erosion and weathering action have played a prominent part in its configuration, and in the formation of the alluvial deposits of tin and wolfram.

Landing in surf boats at mouth of Dungun river.

Native river boat.

The oldest and so far the only tin mine in the state is the Bundi mine, situated near Kuala Kamaman. The mine is owned by a private company, and though it has been a fairly steady producer for a number of years, nothing can be said concerning the nature of the deposit that is being worked, and the methods adopted for its exploitation, owing to the reticence of the owners to divulge any information.

Along the upper reaches of the Sungei Pacca and Sungei Dungun, tin washing by Chinese, and to a less extent by Malays, has been going on for a number of years. The deposits occur in small, irregular, and rich patches along narrow channels of the smaller streams, and the *karang* or tin-bearing gravel, usually about 2 ft. in thickness, is covered by a barren overburden from 3 ft. to 15 ft. In working these deposits the Chinese adopt the usual method in use throughout the peninsula and suitable to this class of deposits of limited area, which consists of stripping the overburden and of the removal of the *karang* to wooden sluice boxes, where it is washed to recover the tin. The water used for this purpose is conveyed to the working faces by means of ditches or bamboos, chain and bucket pumps being used to raise it to the required level. The tin concentrate recovered is exceptionally clean and contains practically no impurities. It varies in size from the fineness of dust to pieces weighing up to 15 lb. of pure cassiterite. The country where the alluvial tin occurs consists principally of slate and schist, but, so far, no tin lodes have been discovered in this locality.

At Bukit Tawang, north of Trengganu town, tin is being worked by hydraulicking. The hill is said to contain tin-bearing gravel which averages 1 lb. to $1\frac{1}{2}$ lb. per cu. yd., and the first shipment of tin from this mine was made in February. This is the first hydraulic mine in the State. As already mentioned, the Chinese washing alluvial tin along the upper reaches of the river Jingah, and following the various creeks feeding this river to their source, discovered the wolfram deposits on Bukit Runtoh, which, however, were previously known to the Malays living near by.

Bukit Runtoh is situated about 25 miles from the coast, rising 2000 ft. above sea level. Viewed from the north, the hill has the outline of a huge tent, with its ridge, which is about one mile in length, striking east and west, both slopes being heavily timbered and deeply carved by narrow gullies and creeks rich in alluvial wolfram, separated from each other by ridges on the summit of which the now worked out outcrops of the veins are markedly in evidence.

The formations at Bukit Runtoh, wherein the deposits of wolfram are found, and of the surrounding country, consist of quartzite, quartz schist, and black and grey slates overlain with clays. The steep, rugged, and in places inaccessible summit and sides of the hill have been subjected to considerable erosion and weathering, and the softer slates have, in parts, been completely removed down to the harder schists, which form the core of the hill. The whole has been greatly disturbed both before and subsequent to the formation of the veins, the whole mass being shattered and broken, resulting in many open

Light tramline from river to mine.

gaps near the surface. The numerous veins occur on both sides of the eastern half of the hill. They have a general strike of N. 72° E. and dip into the hill at angles varying from almost vertical to 55°, the disconnected outcrops being traceable for a length of 300 ft., but underground the continuity of a fissure has been established in one instance over a distance of more than 600 ft. The veins vary in width, rapidly widening and narrowing from 3 ft. to a mere stringer, but they average about 12 inches. Usually one of the enclosing walls is well defined, the other being fractured and the vein matter merging into the country.

The veins in the unaltered slate are uniformly alike, consisting essentially of quartz together with oxides of iron and wolfram, whereas in the softer and oxidized country the veins are filled principally with porous oxides of iron tinted with small quantities of manganese, and a small proportion of quartz, the whole having the appearance of being burned. It is in these ferruginous veins that exceptionally rich and clean wolfram is found.

The shattered and fractured country has helped oxidizing agencies to penetrate deep into the veins, and it is only in the lower levels of the mine that, together with the wolfram, sulphides of iron, copper, and arsenic are found to occur. Above this horizon the sulphides are present in negligible quantities and do not impoverish the concentrate from the sluice boxes. The zone of oxidation forms the limit of profitable mining. Below this level.

Washing for wolfram with native pan or 'dulong.'

Chinese mine contractors.

on entering the sulphide zone, the veins become narrower, and poorer in wolfram and richer in sulphides. They are enclosed in a hard quartzite frozen to both walls, which renders their exploitation difficult and costly.

The wolfram occurs distributed irregularly through the vein in bunches or pockets (the richest portions being where it has been broken and shattered), and is found in a coarsely massive, columnar, or banded structure in a quartz matrix easily detected by the naked eye. Within the clay filling of an open fissure, or between the wall-rock and the vein, finely disseminated wolfram as well as nodules of pure wolfram and wolfram and iron have been found weighing up to 50 lb.

In the space intervening between the pockets of rich ore the veins are usually barren. Practically all the veins so far discovered have been richly mineralized at their outcrops, and the creeks below these outcrops have yielded, and are still yielding, handsome returns in alluvial wolfram, the undertaking having proved very profitable to the Chinese owners.

The ore mined may be divided into two classes, the harder kind mixed with the quartz, and the clayey ore. The wolfram from the former is detached by a hammer and bagged, and the remainder crushed to pass a ¼ in. sieve made out of a kerosene tin, and then washed in a sluice box. The clayey ores are dumped near the sluice box and washed, and the resulting concentrate is dried, bagged, and shipped to Singapore, and contains about 70% tungstic acid.

Before the war there was a keen demand for wolfram in the East. The Germans were the principal buyers, and sent their agents into the interior of Siam to buy direct from the Chinese working in that country. This demand caused a slightly increased production, which however did not affect the price of £100 per ton of 70% ore.

In addition to tin and wolfram, discoveries of the occurrence of silver and lead have been made in various parts of the state, and, in one instance, gold has been found, but so far no work of an exploratory nature has yet been done on any of these discoveries.

The development of a tropical country which is difficult of access, where inland communication is deficient or lacking altogether, and which is sparsely inhabited, must naturally be a slow one. While under Siamese rule, Trengganu was regarded almost as an independent state, and the visit to this territory by Europeans or Siamese was not viewed with favour; consequently the state has remained unexplored and its development retarded, when compared with the neighbouring state of Kelantan, which has been very thoroughly prospected both by the Siamese and by British engineers working on behalf of the large development company which has been operating in that country for over 20 years.

Considering the large area of Trengganu, only a very small proportion of it has been opened. Nevertheless, the discoveries which have been made show that the deposits so far as they have been exploited, although of limited extent, are of great richness and of a sufficiently encouraging nature to justify a campaign of more vigorous prospecting being undertaken in that country.

THE VANNING ASSAY

By PERCY MAYNARD.

THE method, probably the oldest in use, is undoubtedly the quickest of tin assays, and also can be applied with good results on wolfram ores for the determination of cassiterite and wolfram. The details of the operation as conducted at the East Pool and Agar mines follow. The Troy weights are used.

Weigh ½ oz. of finely powdered ore, transfer to a Battersea 'B' crucible, and burn in a coke fire. The changes which occur in the burning are: (1) Iron is converted into iron oxide, (2) arsenic and sulphur are given off in fumes, (3) copper is converted into copper oxide. The ore thus contains tin (and wolfram in this case), iron and copper oxides, and silica. This is transferred to the vanning shovel for the purpose of having the silica, and iron and copper oxides, separated and washed away from the tin and wolfram. This part of the assay requires a great amount of practice before it can be effectively done, the work being similar to gold-panning, and conducted over a tank of water. Finally tin and wolfram only remain on the shovel. The mixture, after being dried, is swept into the pan of the balance for the purpose of ascertaining the value in pounds per ton. One grain is to the ½ oz. of ore as 9 lb. is to 2240, or 1 ton; therefore if the tin and wolfram product weighs 9 grains the value of the ore is 9 times 9 lb. or 81 lb. per ton of ore.

To ascertain the amount of wolfram contained in the product, the whole must be put through a laboratory magnetic separator of 15 amperes, where the wolfram, being magnetic, will adhere to the separator, leaving only tin. In this case, the tin weighed 3 grains, or 27 lb. to the ton, and the wolfram 6 grains, or 54 lb. to the ton. Any iron oxide which may be in the concentrate can be separated by a horse-shoe magnet.

The Cottrell electric precipitation process is in use at the Raritan copper works, Perth Amboy, New Jersey, for saving the fume coming from silver-refining furnaces. The electrodes are made of lead plates and bars, sharpened at the edges. The product recovered contains 800 oz. silver per ton and also 1 oz. gold per ton, together with 6·5% selenium, 6% tellurium, 10% arsenic, 28% antimony, 2% bismuth, 9% lead, and 0·9% copper. The Cottrell apparatus treats the fume after it has gone through settling chambers, flues, and scrubbers.

STANDARDIZATION OF MINING TERMS*

By C. R. CORNING, J. PARKE CHANNING, and GEORGE C. STONE.

The members of this Committee began their work by considering standards already set by the I.M.M., but find it necessary to disagree on certain points, particularly in regard to screens (a matter discussed editorially) and in the use of the term 'ore in sight.' The conclusions and argument are reproduced here in abstract. The Committee will welcome a general discussion.

THE committee recommends the adoption of the following standards:

ORE IN SIGHT.—The committee recommends concerning the use of this term:

1. That members of the Mining and Metallurgical Society of America should not make use of the term 'ore in sight' in their reports, without indicating, in the most explicit manner, the data upon which the estimate is based; and that it is most desirable that estimates should be illustrated by drawings.

2. That as the term 'ore in sight' is frequently used to indicate two separate factors in an estimate, namely: (*a*) ore blocked out, that is, ore exposed on at least three sides within reasonable distance of each other; and (*b*) ore which may be reasonably assumed to exist though not actually 'blocked out'—these two factors should in all cases be kept distinct, as (*a*) is governed by fixed rules, while (*b*) is dependent upon individual judgment and local experience.

3. The estimating engineer shall enumerate and define the different grades of 'ore in sight' and the amount of each. He shall furthermore clearly define what is meant in the report by the terms 'ore in sight,' 'ore blocked out,' or such other general terms as he may use referring to the quantity and quality of ore.

4. That the members of the Mining and Metallurgical Society of America be urged to protect the best interests of the profession by using their influence in every way possible to prevent and discourage the use of the term 'ore in sight' except as defined above; and the Council also strongly advises that no ambiguity or mystery in this connection should be tolerated, as such ambiguity is an indication of dishonesty or incompetence.

UNAUTHORIZED USE OF PUBLICATIONS.—The committee is entirely in accord with this paragraph in the standards of the Institution of Mining and Metallurgy and recommends the adoption of the following:

That in connection with commercial undertakings, no member of the Mining and Metallurgical Society of America shall make use of the discussions on papers or other subjects at the meetings of the Mining and Metallurgical Society of America, or any other documents published by the Society without the written authority of the Council, and of each individual speaker or writer concerned, previously obtained. The infraction of this resolution will be regarded by the Council as justifying disciplinary action by the Council. The Council further considers that all members should insist that their reports and other documents connected with commercial undertakings, whenever published, should be: (1) distinctly dated; (2) published in extenso; or (3) if summarized, the summary should be approved and signed by the member concerned.

MESH OF WIRE CLOTH.—The standard mesh of the Mining and Metallurgical Society of America shall be the standard screen of the W. S. Tyler Co., of Cleveland, Ohio, as described in that company's catalogue No. 36. [We do not reproduce here the details of the screens, as they are given in our Précis, and are discussed in an editorial.—EDITOR.]

WEIGHTS AND MEASURES.—1. For all Spanish-American countries, and all other countries where the metric system of weights is the legal one, a statement concerning measures and weights of whatsoever kind shall be in the metric system. All references to temperature shall be in degrees Centigrade. In Spanish-American countries and in all other countries which have adopted as their legal standard of weight and measures the metric system, the gold and silver contents of ores, alloys, bullion or other materials, must be stated in decimal fractions of the weight of the material, or in percentages and decimal fractions thereof or else in kilos of silver and grammes of gold per metric ton of material.

2. The word 'ton' shall represent a weight of 2000 lb. avoirdupois (29,166·6 oz. troy). It is advisable to abandon the use of such terms as 'hundredweights' and 'quarters,' and to express fractions of a ton in pounds or decimals of a ton.

3. The term 'miners' inch' shall represent a flow of 1·5 cu. ft. of water per min. Where this unit is not customary and currently acknowledged, the flow of water should be expressed in cu. ft. per min. or per sec.

* From a partial report of the Committee on Standardization of the Mining and Metallurgical Society of America.

4. In the United States, the unit of liquid measure is the standard gallon of 231 cu. in. In England, and the British Colonies which have legalized the unit, the 'Imperial Gallon' measure of 10 lb. of water is to be used. In every case all reports should state definitely which gallon is used therein.

5. Temperature should be expressed in degrees Centigrade. Subsidiary use of the Fahrenheit scale is admissible; but only conjointly with the Centigrade, and not alone.

6. Returns of gold and silver shall be expressed in terms of fine gold and fine silver respectively, not as 'bullion.'

7. Gold and silver contents of ores determined by assay may be expressed in money values per ton of 2000 lb. avoirdupois, as well as in weight per ton. In this connection, the value of gold shall be taken at 85s. sterling, or $20·67 U.S. currency, per troy oz. of fine gold. All other constituents of alloys, metallurgical products, or other material must be given in percentages.

Bullion and Assay Values.—The following is proposed concerning these terms:

1. All samples should be dried at 100° C. before being subject to assay or analysis and reports should definitely state that this precaution has been taken.

2. Assay values of gold and silver ore and products should be represented in ounces and decimals and not in ounces, pennyweights, and grains. They shall always be expressed in terms of fine gold and fine silver respectively and not as 'bullion.'

3. Assay values of alluvials shall be reported in grains and decimals of a grain of fine gold, or in pence (at 2d. per grain of fine gold), or in cents per cubic yard. It is recommended that, in the absence of specific information as to boulders, etc., 1 cu. yd. of ordinary alluvial be taken as equivalent to 3000 lb. (1·5 tons).

4. In reporting assay values of cyanide and other solutions, the results shall be given in parts by weight in a stated volume of the solution. In the case of cyanide solutions, the use of the 'fluid ton of 32 cu. ft.' is recommended. It closely approximates to 2000 lb. and is in common use.

5. When it is necessary to state or estimate the money value of an ore, etc. (other than gold), the contents shall be given in percentages of the base metals, and in ounces of gold and ounces of silver. If it becomes necessary to estimate the value of the ore in money the first step would be a deduction from these percentages to allow for metallurgical losses and the next following step the calculation of the value of the recoverable metals at definite fixed prices. If the net value of the ore is required then from the above should be deducted the working and realization costs.

6. We recommend for all laboratory sieving the Tyler standard screens.

Argument in Above Conclusions.

The committee submits the following reasoning in discussing the standards of the Institution of Mining and Metallurgy and in explanation of such dissent as we express.

Ore in Sight.—Paragraphs 1, 2, and 4 of the standards of the I.M.M. should be accepted. Paragraph 3, which reads as follows:

"That in making use of the term 'Ore in Sight' an engineer should demonstrate that the ore so denominated is capable of being profitably extracted under the working conditions obtaining in the district,"

should be replaced by the following:

"The estimating engineer shall enumerate and define the different grades of 'Ore in Sight' and the amount of each. He shall furthermore clearly define what is meant in the report by the terms 'Ore in Sight,' 'Ore Blocked Out,' or such other general terms as he may use referring to the quantity and quality of ore."

Unauthorized Use of Publications.—The committee is entirely in accord with the Institution of Mining and Metallurgy in the matter of unauthorized use of publications, and therefore recommends as above adoption not only of the substance matter, but of the wording of that Institution's standard.

Mesh of Wire Cloth.—It will be remembered that the Institution of Mining and Metallurgy devised and recommended a standard screen based upon a screening area of 25%. The committee believes this standard to be disadvantageous, and has therefore made the substitution above suggested. This argument is based on the fact that it is not always desirable to have the wire the same size as the opening. The Tyler scale is based on opening alone.

Weights and Measures.—Attention is called to the fact that for all Spanish-American countries the sole legal system of weights and measures is the metric; also that in a great many of these countries, which closely follow the old French law, evidence concerning weights and measures is not valid unless expressed in metric units. It is consequently desirable that all reports and statements should be expressed in metric weights and measures in documents dealing with properties in Spanish-American countries. All temperatures should be expressed in Centigrade.

The Institution of Mining and Metallurgy standardization of weights and measures reads as follows

(1) The word 'ton' shall represent a weight of 2000 lb. avoirdupois (29,166·6 oz. troy). NOTE.—It is advisable to abandon the use of the terms hundredweights and quarters, and to express fractions of a ton in pounds or in decimals of a ton.

(2) The term 'Miners' Inch' shall represent a flow of 1·5 cu. ft. of water per min.; and the term 'sluice head' shall represent a flow of 60 cu. ft. of water per min. NOTE.—It is advisable to abandon the use of both terms, as being merely of local usage, in favour of definite expression of the flow of water per min., or per second, in cu. ft. or in gallons.

(3) The word 'gallon' shall represent the Imperial Gallon measure of 10 lb. of water.

(4) Temperature shall be expressed in degrees Centigrade.

(5) Returns of gold and silver shall be expressed in terms of fine gold and fine silver respectively, not as 'bullion.'

(6) Gold contents of ores, etc., determined by assay, shall be expressed in money values as well as in weights; and in this connection the value shall be taken (as a convenient constant) at 85s. or $20·67 U.S. Currency per troy oz. of fine gold.

The committee is in accord with paragraphs 1, 4, 5, and 6.

It is also in accord concerning the standardization of the 'miner's inch' as a flow of 1·5 cu. ft. of water per min., but does not believe that the term 'sluice head' should be used; and that when 'miner's inch' is not a customary unit of measure the same should be cubic feet per second. It is also opposed to the use of the Imperial gallon in the United States, and believes that the customary gallon of 231 cu. in. should be recommended by the Society, and that all reports should state that such is the gallon used. For reports dealing with interests in Great Britain or such of her colonies as use the Imperial Gallon the latter is to be recommended, providing always that it is clearly stated that it is the Imperial Gallon which is used as a unit.

BULLION AND ASSAY VALUES.—Under this heading the Institution of Mining and Metallurgy has promulgated the following six paragraphs:

(1) Assay reports shall state the exact condition of the sample as to dryness, when assayed.

(2) Assay values of gold and silver ore and products shall be represented in pennyweights and decimals, or in ounces and decimals, and not in ounces, pennyweights, and grains. They shall be expressed in terms of fine gold and fine silver respectively, not as 'bullion.'

(3) Assay values of alluvials shall be reported in grains and decimals of a grain of fine gold, or in pence (at 2d. per grain) of fine gold, or in cents per cubic yard. It is recommended that, in the absence of specific information as to boulders, etc., 1 cu. yd. of ordinary alluvial be taken as equivalent to 3000 lb. (1·5 short tons).

(4) In reporting assay values of cyanide and other solutions, the results shall be given in parts by weight in a stated volume of the solution. In the case of cyanide solutions, the use of the 'fluid ton of 32 cu. ft.' is recommended. It closely approximates to 2000 lb. and is in common use.

(5) When it is necessary to state or estimate the money value of an ore, etc. (other than of gold), it shall be accompanied by the assay value, and the basis on which the former has been calculated from the latter shall be stated.

(6) Laboratory sieving tests shall be made with the I.M.M. standard sieves, or, when other sieves are used, the widths of the apertures shall be stated.

The committee is in full accord with paragraphs 3 and 4, and for paragraph 6 recommends the Tyler Standard Screens. It is further of the opinion, with reference to paragraph 1, that all samples should be dried at 100° C. before being subjected to assay or analysis, and that the report should definitely state that this precaution has been taken. So far as paragraph 2 is concerned the committee desires to see the question of pennyweights and decimals completely eliminated.

Dealing with the subject matter of paragraph 5, it seems to the committee that the contents of ores other than perhaps straight gold and silver should be given in percentages of the base metal, and for gold, and silver in ounces troy per ton of 2000 lb. If it becomes necessary to estimate the value of the ore in money the first step would be a deduction from these percentages to allow for metallurgical losses; and the next following step the calculation of the value of the recoverable metals at definite fixed prices. If it becomes necessary to give the net value of the ore then from this should be deducted the working and realization costs.

FURTHER STUDIES PROPOSED.

The committee has in mind, for further consideration during the summer, the remainder of the standards of the Institution of Mining and Metallurgy, so far as they have not been discussed in the preceding paragraphs. Consideration will also be given to the standards of the United States Bureau of Standards, and to those of certain associations and societies in the United States. It is proposed also to consider standard methods for making and reporting laboratory and screen analyses, wet methods of chemical analyses, admissible limits of error in assays and analyses, the question of uselessly verbose and therefore frequently obscure reports, technical papers, and books; and in view of the increasing interest in South and Central American enterprises it is proposed, if possible, to secure from the various Governments of those countries information concerning the legal and more customary local units of weights and measures, and their equivalents in metric and United States units.

DISCUSSION

Tin and Tungsten in the West of England.

The Editor:

Sir—I have read in your October issue Mr. J. H. Collins' very instructive article on the above subject. There are a few facts relative to production, however, on which the information given by Mr. Collins is not quite complete; and a few points in regard to methods of treatment which may admit of difference of opinion. I shall refer more particularly to East Cornwall, and South Devon as far east as the western fringe of Dartmoor. This may be regarded as one mining area in view of the general similarity in geological and mineralogical features, and is probably richer in tungsten than any equal area in Europe. I have spent over twenty years in this field on the production primarily of tin or tungsten, or both, and feel confident it will figure prominently in the future returns of these metals, tungsten especially.

Mr. Collins states that of the tungsten minerals wolfram alone has been met with in quantities of economic importance. This is not quite correct. The amount of one ton sold from Wheal Friendship in 1909 was not in the form of wolfram, but as tungstate of soda, obtained from the treatment of scheelite by the Oxland process. The mineral was found in a lode containing about 6% As_2O_3 in the mineral mispickel, together with 0·3% cassiterite, and 0·4% scheelite. These are recoverable amounts. The ore was treated for arsenic, and the tungstate of soda was obtained from the calcined residue. Recently a further quantity of this residue was treated for its tin and tungsten contents, and 27 tons of clean concentrate was obtained, assaying 36% Sn and 23% WO_3. In the meantime the small plant erected for the earlier production had been dismantled, and a market was sought for the sale of the mixed tin-scheelite concentrate. A sale was eventually effected for both tin and tungsten contents.

The Oxland process was adopted in the case first referred to above because scheelite is non-magnetic, and magnetic separation was therefore not possible.

While I was on the staff of the Clitters Mines, from 1900 to 1907, quite 300 tons of clean wolfram concentrate was obtained by magnetic, separation. The Wetherill machine used was the first magnetic separator installed in Britain for the separation of tin-tungsten minerals. A large proportion of the ore treated came originally from Holmbush, Redmoor, and other local mines. After being crushed by rolls and passed through a 1 in. screen, it was calcined for its arsenic contents and the residue rejected, but it attracted attention for its tin-tungsten values when the magnetic separator became a proved success. It had then been lying as a waste dump for many years. Corrosion and cementation had set in, due to internal decomposition of the residual oxides and partly calcined sulphides, accelerated by atmospheric influences. Consequently a large proportion of the wolfram particles, even after crushing and preliminary concentration, was coated in varying degrees with oxides of iron. As a result the weaker magnet, which should have extracted only the iron oxides, attracted a considerable quantity of particles which were mainly wolfram. This product was mostly very fine and difficult to dress to marketable quality. It was decided to treat it by the Oxland process, and the manager, Mr. Josiah Paull (now of South Crofty) put down a small plant for this purpose. The results, however, were not entirely satisfactory, further buddling and magnetic separation giving a better recovery even on this most difficultly separable portion, than was obtained by the Oxland process. The 'pickling' process, of which Mr. Josiah Paull was the originator, was then applied to this material, and the results obtained justified its wider application on practically all the wolfram products of the magnetic separator, whether coarse or fine; and not only on account of removal or separation of iron oxide, but also because it liberated particles of cassiterite from attachment to the wolfram particles.

It is obvious that the best results of magnetic separation are obtained when both the cassiterite and wolfram occur in coarsely crystalline form, and in unoxidized lodes in which there has been a minimum of corrosion; but I can conceive no conditions under which the Oxland process is generally preferable to magnetic separation of these minerals. The former method, when applied to the treatment of tin-wolfram ores, and under constant expert supervision, leaves more tungsten in the final tin product than will equal the value of the tin and wolfram remaining as impurities in the products obtained by magnetic separation. Unless the fusion is very skilfully conducted, there is also a small but varying loss due to the formation of sodium stannate, which is not recovered in the subsequent lixiviation, etc. There is a further loss of tin in the pulverization and final cleaning of the residue. It is necessary to grind fairly fine, at least through a 50-mesh. The loss may be reduced to a minimum by stage grinding and recovery of the cleanly separated cassiterite between the stages.

Comparison of cost of plant for the two methods cannot be standardized, but the figures are certainly in favour of the magnetic separator where a supply of electric current is available without the necessity of erecting a special electric plant. In actual treatment of the concentrate magnetic separation scores heavily. The material to be treated may merely require drying, but if 'pickling' with H_2SO_4 is necessary, neither this nor the subsequent washing is costly.

The Oxland process is slower, requires more skilled supervision, is comparatively costly on account of the soda ash and fuel necessary, and is much more expensive in maintenance. The Oxland process is as applicable to tin-scheelite as to tin-wolfram ores. It should be noted, however, that a charge of clean tin-scheelite concentrate requires 20 to 25% longer in fusion than a similar quantum of clean tin-wolfram concentrate containing similar amounts of tin and tungsten.

It is notable that nearly all the lodes in the West of England which yield wolfram in commercial quantities contain practically no scheelite, while the converse is true of the scheelite lodes.

To Mr. Collins' list of mines that have yielded ores of tungsten may be added:

1. Devon United (Petertavy), small selected quantities of scheelite.
2. Danescombe (Calstock), small quantities of wolfram.
3. Hawkmoor (Gunnislake), wolfram.
4. Jewell, Wheal (Marytavy), specimens of scheelite only.
5. Prince of Wales (Callington), wolfram, specimens only.
6. Tamar, Wheal (Gunnislake), wolfram.

I thoroughly agree with Mr. Collins that far too much has been spent in re-opening and equipping old and deep mines, to the neglect of mines of moderate depth, and exploratory work in known good districts. In addition to those localities of good promise indicated by Mr. Collins, I would add the locality northeast of Tavistock, in which many lodes of distinct promise are known to exist.

ERNEST TERRELL.

Marytavy, Devon.
October 30.

[Our correspondent's account of work done at Clitters is of particular interest, because little relating to technology has been published in connection with the Hingston-Clitters group of mines. On their reopening a dozen years ago, there was every expectation of a big stride being made in the beneficiation of complex tin ores, and the premature failure of the enterprise, owing to faulty finance and neglect of underground development, was generally regretted.—EDITOR.]

The Rooiberg Report.

The Editor:

Sir—At the ordinary general meeting of the shareholders of the Rooiberg Minerals Development Co., Ltd., in 1912, the chairman stated that "The plant is working satisfactorily, and in it we may, I think, lay claim to possessing the most modern tin-dressing plant in these or any other fields." However, each following year it was found necessary to incur fresh capital expenditure, with the result that the 'Mine Equipment' account reached in 1914 the respectable sum of £120,462, for a 10-stamp tin treatment plant. Imitating the bad example of some gold mines, this account is no longer specified in the balance sheet for 1914-15, being merged into the 'Property Account.' It would be interesting to know the reason for the creation of a hiding place for such an important item. The installation of additional rag frames has been followed by the decision to erect a sufficient number of Deister tables, and at the same time experiments are now said to be carried on for separating "the crystalline particles from the colloidal matter" by a centrifugal separator, "which imparts a force equal to five or six hundred times that of gravity." Whatever may be the merits of the apparatus, the reason in the form as given above cannot be accepted as a convincing explanation, because the force as such does in no way affect the ratio of the specific gravities of the gangue and the metallic contents.

Fully appreciating the progressive spirit and the enterprise of the directors and their technical adviser, I, happening to have an intimate knowledge of the present practice, cannot help thinking that an endeavour to work first the existing units to their best advantage should precede further capital expenditure for new machinery.

As a preventive for possible criticism of never ending capital expenditure and of high working costs (£2. 2s. 8d. per ton), Mr. Way, the consulting engineer, cheers the shareholders by the statement: "In four years working costs have been reduced by £1. 7s. 6d. per ton, and the extraction of the metal has improved 20·3%." This statement is, of course, statistically and mathematically correct, but in the light of actual facts it is misleading. It may be characterized as clever window dressing.

The first of the four years, with which the results of the year under review are compared, was the last year of existence of the old mill. In view of the early start of the new mill, only the bulk of the black tin was recovered, and the middling and tailing of an average value of 2·5% metallic tin were put aside for re-treatment in the new plant. There is therefore not much cause for boasting about the performance of improving on the extraction results of a plant which at that time was in a state of "rapid deterioration," as was announced at the general meeting of 1912, when the chairman explained these poor results.

With regard to the working costs, it is true that a reference is made in the report to a considerable curtailment in 1915 of the expenditure on development and exploration. Had this expenditure been the same as in 1912, the claimed reduction of the working costs per ton would have dwindled from £1. 7s. 5d. to 14s. 5d. Besides this correction another fact, of which no mention is made in the report, must also be kept in mind. In 1912 the total ore had to be mined, sorted, and crushed, while in 1915 the considerable expenses under these items were not incurred for the re-treatment of the accumulated middling and tailing, which to the extent of 28·9% of the total ore treated could simply be taken from the dump close to the battery.

H. STADLER.

Royal School of Mines,
October 22, 1915.

[We publish Mr. Stadler's letter, not because we agree with all of his criticisms, but in the hope that it will elicit additional technical information about concentration practice in the Transvaal tinfields. Window dressing, which we join Mr. Stadler in considering deserving of opprobrium, is unfortunately one of the amiable failings of even the greatest of commercial companies and of the most trustworthy banks, so that really the criticism should be general rather than particular. Moreover the transfer of the cost of machinery from one section of the accounts to another is a usual practice among accountants and auditors, though of course the mining man resents the consequent difficulty of dissecting the items of expenditure. An intelligent and unprejudiced perusal of the successive yearly reports of the Rooiberg company affords elucidation of the policy of the engineers and of the results obtained, and though one of the reports taken by itself may not convey complete information, reference to preceding reports will supply the deficiency. We have on previous occasions mentioned that the problems of concentration at a shallow horizon are different from those to be faced at depth, owing to the gradual change of the cassiterite from coarse to fine grain as the workings go down. The engineers of the Rooiberg seem to have done fairly well, and our own criticism will be reserved until their results are published in full.—EDITOR.]

Moisture in Mine Air.

The Editor:

Sir—In the Précis in your August number you give brief notice to a paper on 'The Influence Moisture in the Air has on Mine Ventilation,' read by Mr. Arthur C. Whittome before the South African Institution of Engineers and published in the *Journal* of that Institution for June. As you indicate, the paper is one of much interest and doubtless many will regret that your space did not permit a more extensive abstract. I venture to ask space in which to discuss some of Mr. Whittome's conclusions and other matters raised by what he has said, all the more because, from metal mining engineers in particular, ventilation problems have received too little attention.

Mr. Whittome uses the words 'oxygen stuff' to represent the dry air portion of the atmosphere, whether dry or saturated. He considers the term is convenient, but it strikes me, owing to the extremely variable relation between oxygen and nitrogen, that it is somewhat misleading and not necessary. In discussing the amount of air necessary he quotes Trautwine's figures that when a grown person works hard he breathes from 0·5 to 1·05 cu. ft. of air per minute, which Trautwine says is two to three times the amount he requires when at rest. Trautwine, however, does not state, and evidently overlooks saying, that these figures would not do in a confined space since it will be found on figuring that it involves the consumption of *all* the oxygen of the air, whereas one-fourth of the oxygen is used and the exhaled breath contains about 4 per cent. CO_2 under normal conditions, and this is true regardless of the altitude and rarity of the air. From the self-contained oxygen breathing apparatus we know very decisively just how much oxygen is needed. The Draeger apparatus was formerly set at 2 litres per minute, but as is well known, this does not permit consecutive hard work, but on the average it is believed that 3 litres per minute will take care of average hard work counting on short periods of rest. This is equivalent to 15 litres of air per minute, or one-half a cubic foot. It is hardly worth while figuring on the maximum amount named, as that is not a rate of work which could be well maintained. Now to keep the oxygen content of the air above $19\frac{1}{2}\%$ and the CO_2 content less than 1%, which is good practice, it would manifestly take 20 times $\frac{1}{2}$ cu. ft., or 10 cu. ft., as representing the average amount needed for a working man in a closed place per minute, and to keep down to the South African requirement of 0·2% CO_2 would require five times this, or 50 cu. ft. of air per minute. The South African requirement of 70 cu. ft. under the old Mines and Works Regulations, or 200 to 250, stated to be a common standard at present, seems unnecessary in view of the experience in coalmining.

Incidentally the figure quoted from Mr. Rathbone's article, placing the maximum amount breathed per person at 12·5 cu. ft. per hour, must certainly have been a typographical error, the real figure being 12·5 cu. ft. per minute.

The calculations made on the basis of Trautwine and Rathbone's figures are for the complete consumption of the oxygen, which means practically that an equal amount of CO_2 is produced. There is, of course, some loss through the production of water and other compounds, but to all intents and purposes this is negligible in figuring the relation of the exhaled air to inhaled air, which under normal conditions is about as 0·9 to 1·0, so that instead of the first figure he names of 0·02 exhaled CO_2 it should be 0·1, hence instead of the figure the author takes of 10·5 to 22 cu. ft. fresh air per minute it should be about 50 to 110, though, for reasons already indicated, the maximum is hardly worth while taking.

The assumption that the author makes that unsaturated water vapour behaves like superheated steam, while superheated steam has been found to behave very nearly like a perfect gas, is correct. Following this are statements regarding humidity and condensation of water vapour, and tables, which while presenting no new facts, seem to be of material convenience for reference, obviating tedious calculations. These tabular statements are also accompanied by curves which strikingly bring out the comparison between density and elastic force of water vapour and densities and volumes of dry and saturated air, and finally a set of curves which are unusually striking, and which show the increase in volume of air at the same barometric pressure, but with increasing temperature and water vapour content in order to carry the same amount of oxygen. The curves are very suggestive.

The author states "Immediately upon the cessation of heavy rain the atmosphere can be considered as being 100% saturated." While this may be true at times, I am persuaded that the condition is exceptional. According to officials of the Weather Bureau it is by no means necessarily true. On September 9 I tested the matter and found that during the rain relative humidity was 88. It dropped to 85 when the rain ceased. Later in the afternoon, when it again rained, it stood at 85, but rose to 95 slowly after the rain ceased. In the clouds the air is of course supersaturated. A saturated condition in the atmosphere is rarely found except when it is foggy.

Mr. Whittome also makes certain assumptions about the normal humidity of air in the Rand district. It seems as if there must be some records and one wonders if 50 to $66\frac{2}{3}\%$ really does represent the average condition.

The author states "A great proportion of the heat absorbed by the vapour is derived from the body of water from which the vapour is formed, and from the solids (such as country rock, etc.) with which the water is in contact during evaporation, thereby reducing their temperatures instead of that of the air." Experience in this country has not indicated that there is any support for this contention, and the regular system of cooling of air in woollen and cotton mills used throughout the country is with sprays in the intake, so that this will reduce the temperature of the air. This it will usually do to at least 10°. The temperature of the moving air current in a mine is not long in assuming the temperature of the walls, and outside of the local effect it has very little influence upon the final temperature of the air; for example, to show how rapidly the air assumes the temperature of the walls see Bureau of Mines Bulletin No. 20 and No. 84, and Geo. G. Young's article on the ventilating system at the Comstock (Trans. Amer. Inst. Min. Eng., Vol. 41).

Regarding the effect of CO_2 absorbed by water causing corrosion of pumps, pipes, etc., this idea was at one time advanced, but present opinion among physicists, I believe, rather tends to discredit it, at least as being quantitatively important.

To the author's suggestion that "Medical men, if they have not done so might well investigate the results on human beings due to the variation in the volume of air which must be inhaled under varying pressues and temperatures," I would call attention to what has been done already by a number of British and European medical men, including Dr. J. S. Haldane, and in America by Dr. Henderson, consulting physiologist of the United States Bureau of Mines.

Perhaps the most novel suggestion made by the author is that relating to condensation of water in the lungs. He states: "It would seem that when a person breathes saturated air at a temperature above blood-heat there must be a condensation of water vapour in his lungs, and the resultant water (almost certainly carrying deleterious gases or matter if the person is in a mine) must have a detrimental effect on the lungs and retard them in the efficient performance of their functions." I may mention, in the first place, that situations where the miner is called upon to work at temperatures above blood-heat, 98·4°, and which at the same time is saturated, are very rare. While the Bureau of Mines has made many determinations it has never found one, and if Mr. Young's figures on the Comstock are examined it will be found that there are only a few places in that mine where that condition was found, and it is not clear that it was where anyone was working. Usually the water content of the atmosphere remains about uniform, and as the temperature goes up the relative humidity goes down. Regarding the condensation of water vapour in the lungs I have consulted Dr. J. A. Watkins of the Public Health Service, who stated that he did not believe that the water so condensed would be troublesome in the lungs. In all probability it would condense in the nose or mouth, or in the throat passages, which could be easily expelled, or from the bronchial tubes, from which if in excess it would be expelled by coughing, but it does not seem probable that it would get past the throat as the air breathed rapidly attains the temperature of the body. Both Dr. Watkins and I have been in vapour baths, where I believe the temperature was about 130°, and did not notice that the condensation of the water in the passages or in the lungs even caused one to cough, or was in any way troublesome. Dr. Watkins says that there are certain diseases in which water collects in the cells in such amounts that it practically produces the effect of drowning, but there is very little reason to believe that such would be the case in a mine under the most severe conditions where a man could work for more than a few minutes at a time; and it would be utterly out of the question that he would work in such a saturated atmosphere for an 8-hour shift for other reasons. The lack of evaporation of moisture from the skin would so raise the bodily heat that it would be dangerous to remain at work for 8 hours, and few men would be likely to do so.

In conclusion, I congratulate Mr. Whittome on having brought together some very suggestive and well-established data regarding the relation between humidity, temperature, and barometric pressure. The suggestions which are new relate to the disadvantage of using old spray water, which contains CO_2, and which if evaporated would again give off CO_2; also the suggestion as to the corrosion of metal by water containing CO_2. Finally the suggestion that the saturated atmosphere at high temperature would be dangerous on account of the condensation of water in the lungs, is distinctly new. While it is a hypothetical question in virtually all mines with which I am familiar, nevertheless it is one of interest. Judging from the statement of Dr. Watkins it does not seem probable that the water condensation through reduction of temperature to that of blood-heat would get as far as the lungs.

GEORGE S. RICE.

Pittsburg, Pa.

September 15, 1915.

[We are greatly indebted to Mr. Rice for his careful review of this subject. As he states metal miners are far too ignorant of such matters, and we are sure that both what he has written and Mr. Whittome's tables will be found of much service. As Chief Engineer for the United States Bureau of Mines, following several years successful professional practice, Mr. Rice is peculiarly well qualified to speak with authority.—EDITOR.]

SPECIAL·CORRESPONDENCE

TAVOY, BURMA.

TAVOY is in the throes of an unprecedented boom and is vigorously working existing wolfram concessions as well as seeking new areas, of which there are several in course of being opened. Buyers for home smelters are in active competition and have helped to increase the output by the high prices which have been paid since June. As much as £170 per ton of high grade concentrate (73% WO_3) has been paid locally. Freights from Rangoon to London have increased one-third to 73s., and local costs are somewhat on the increase, but the mining cost does not exceed £60 per ton.

The leading producer still keeps its output at over 70 long tons monthly, and others aspire to this, with every chance of attaining it if the streams do not fail too soon. Owing to the comparative failure of the rains, only 177 in. having fallen since January 1, whereas the previous year totalled 202 in. to date, it is feared that sluicing will have to be curtailed. As much ore is won by this means, it is hoped that a magnetic separator plant to separate the tin from the wolfram may be built. The demand for such a plant is the more urgent in that export of mixed concentrate for separation treatment in the Federated Malay States is prohibited in order that the control of the ore may be maintained.

Much general satisfaction has been given by the action of the Ministry of Munitions in fixing the price per unit of tungstic acid at 55s., the effect being to convert mines into 'gilt edge' securities comparable to gold mines. Latest information is to the effect that all ores will be distributed by a Liverpool firm of metal merchants on behalf of the Government. It is regrettable that English mining firms still hold aloof, nor can this fastidiousness be understood with profits per ton ranging from £80 to £100. Various important and most helpful developments may be expected in the near future, but as these are under consideration by Government only general reference is permitted. The local Chamber of Mines has brought forward the restricting of areas granted under prospecting licenses to a maximum of two square miles, and official approval may be expected. The output during the year has been: First quarter, 498 tons; second three months, 412 tons; with 272 tons for July and August. The total, 1182 long tons, shows about 10% increase over last year, for which the tonnage was 1631 for the twelve months.

JOHANNESBURG.

GOLD PRODUCTION AND THE WAR.—It is gratifying that despite the unsettled state of affairs caused by the recent rebellion and the European war, the gold output for the last twelve months has continued to increase to such an extent as closely to approach the record figures reached over two years ago. These results are far better than anyone dared to prognosticate at the outbreak of the European war. The feature of the last available monthly return was the fact that the tonnage crushed was only 22,000 tons short of two and a half millions. Month by month it becomes evident that if the total yield of gold on the Rand is to be maintained it can only be accomplished by crushing increased tonnages, especially while operations are confined more or less to the same mines. Last month, however, the recovery per ton milled showed a slight improvement, the explanation being that the new producers in the Far East Rand were milling higher grade ore than the average of other mines. Much has lately been said at shareholders' meetings about the higher prices of stores and materials raising the working costs, and it is interesting to notice that these are now about sixpence per ton higher than a year ago. The whole of this increase can be easily traced to the higher costs all round of mining material and stores. One encouraging feature of the local gold-mining industry is the ample supply of unskilled native labour, which is most exceptional at this time of the year. This, with the probability of mills being enlarged or built at several of the Far East Rand mines, gives a cheerful aspect to the immediate future of gold production.

EARTH TREMORS.—An unusually severe earth tremor was felt in the town on the night of September 27, the sensation in all respects being similar to that produced by a veritable earthquake. Both the main and incline shafts at the Village Main Reef mine were damaged to such an extent, accompanied by falls of rock, that it is estimated that three weeks will be required to completely repair the shafts. In my previous letters attention has been devoted to the discussion of these earth tremors, and the opinion was expressed that they would probably be found to be due to mining operations rather than earthquakes. At the sittings of the Government Commission now being held to inquire into the cause and prevention of these tremors, the same opinion has been expressed by most of the witnesses in their evidence, a digest of which was given in my last letter. With regard to the accident at the Village Main Reef on September 27, the outstanding feature appears to be the damage done to the shafts, a feature which merits some attention, as if properly investigated it may throw some light on the cause of these so-called earth tremors, and the best steps to take with the object of reducing their ill effects to a minimum. In my last letter when commenting on the evidence tendered before the Commission of Inquiry, special attention was drawn to that of Mr. Stuart Martin, who recommended that as many small pillars as possible should be left behind in the stopes, while he also expressed the opinion that the more numerous the tremors the better the ultimate settlement would be. This evidence was criticized in my last letter in dealing with the whole subject, when I pointed out that to leave numerous small pillars was generally considered bad mining, as in deep mining they would be useless and inimical to a gradual and proper settlement of the overlying hanging wall. The occurrence at the Village Main Reef, taken along with the experience at the adjoining Ferreira Deep, more than confirms my opinion as to the danger set up by pillars in the last days of a mine where extensive sand-filling operations or close packing have not been resorted to. There can be little doubt that these earth tremors are principally caused by the leaving behind of inadequate pillars. To be adequate, without being accompanied by sand-filled or closely packed workings, it is evident that they must be of such a size as absolutely to prevent any bodily movement of the superincumbent strata. In the present state of affairs on the Rand it therefore follows that unless the exhausted workings are closely packed or sand-filled, a depth must be reached at which the necessary pillars will be of such a size as to make successful mining out of the question. The fact that at the Village Main Reef and the Ferreira Deep the bulk of the damage was done to the shafts and levels where pillars had been left for their protection, points in the direction that on the Rand, where considerable areas of exhausted and open workings exist, pillars are rather a snare than a protection to the underground workings. Further the behaviour of sand-filled workings when these underground subsidences and earth tremors make their appearance proves that sand-filling and packing prove a better protection than solid pillars, and therefore far more efficient in reducing the ill effects of these underground settlements to a minimum.

SAN FRANCISCO.

COPPER MINERS' STRIKE.—In Arizona, at the mines of the Detroit Copper Mining Co., Arizona Copper Co., Ltd., and Shannon Copper Co., situated in the Clifton-Morenci-Metcalf district, a vindictive miners' strike has been taking place. That old disturber, the Western Federation of Miners, of unsavoury fame in half the districts of the West, with the assistance of Mexican agitators, aroused the men to a general strike on September 11. The mining companies called upon the sheriff to protect their property, but, as usual in such cases, the political officials, including the Governor of the State, were practically useless. To lessen the bitterness of feeling that was being encouraged by the agitators, the three mine-managers departed on a locomotive, finally reaching El Paso. The mining companies state that they cannot grant the demands of the strikers for increased wages because this district is the highest-cost producer of copper in the State, the copper of the largest of the three companies costing nearly 13 cents per pound, while the average price of copper for the past 10 years has been below 14 cents. The Mexican miners have been receiving from \$2·73 to \$2·88 per day, and the Americans from \$3·30 to \$4. Meanwhile lawless scenes and acrimonious statements are the rule in this district, which produces 6,000,000 lb. of copper per month and ordinarily gives employment to 5000 men, of whom 85% are Mexicans.

In connection with the strike in Arizona, it is interesting to note that in the coalfields of Colorado, where an even more bitter strike was settled a few months ago, John D. Rockefeller, Jr., the principal shareholder, against whom the bulk of criticism was directed, has been making a personal tour of inspection. His presence in this mining community, while more or less of a sop to public hysteria, has had an undeniably beneficial effect on all phases of the local labour problems. A scheme of industrial co-operation, for the settling of grievances by a committee of miners and employers, has been proposed by him and his advisers, which may serve to satisfy the grievances of the employees. In the Lake Superior copper region, where there was a protracted strike of the miners two years ago, ultimately won by the mining companies, quiet and orderly conditions now prevail.

EFFICIENCY. — In the mining circles of this country 'efficiency' is the magic word, much as 'flotation' is the great topic in metallurgy. Investigations into underground work, similar to those beginning on the Rand, are being conducted with a varying degree of success depending upon the temper of the managements, labour conditions, and the need for reducing costs. The question of efficient rock-drills seems to have been settled, an increasing majority of opinions favouring hammer-drills, mounted and unmounted, for hard rock in particular. Recently attention is being directed toward new drill-bits, the difference of gauge on successive steels, and the requirements for drilling longer holes, up to 16 ft. The so-called Carr bit is being widely adopted, under careful supervision in the sharpening-shops, to reduce the difference in gauge to $\frac{1}{16}$ in., if possible.

FLOTATION.—This method of concentration is growing constantly in popularity, and mills in nearly every mining state are investigating and installing apparatus for the process. It is even predicted that leaching of copper ores will become extinct because of the success of the 'bubble' method of "concentration upside-down." Remodelling of reduction-works, such as the Anaconda Co.'s is the rule, at copper and zinc properties especially. Oddly enough the theory of the process, the physics of the buoyed ore-particles, is not at all understood as yet. To a considerable extent the adoption of the process to any particular ore has been accomplished by cut-and-try methods, experimenting with various oils and with different means for agitation, as well as the devising of a system of treatment for the concentrate effected. By the way, it is a remarkable fact that no mention whatever was made of flotation at any of the meetings of the Mining Institute or the Engineering Congress when they were in session here in San Francisco last month. The important suit brought by the Minerals Separation Company against the Miami Copper Co. has been concluded and a decision is expected at an early date. This, of course, will not end the litigation ; an appeal to the higher court is inevitable, and after that the final appeal to the Supreme Court, so that we shall have to wait some time before the matter is settled. Meanwhile the mining public is becoming keenly awake to the importance of the process and tests are being made on a great variety of ores.

GOLD.—Interest is manifest in the recent finds of gold in the Oatman district of Arizona, near the California line. This and the neighbouring district of Kingman have had several minor booms during the past ten years. The recent excitement, leading to the promiscuous staking of claims in the neighbourhood, has been largely the result of the successful development of the United Eastern mine, which is under the direction of Seeley W. Mudd. On the 565-ft. level, which is the bottom of this mine, a rich orebody has been uncovered. The Ivanhoe is another promising enterprise in this district. The Tom Reed and Gold Road mines, in the same vicinity, have been operated for five or six years without startling results, but with a fair measure of success.

TORONTO.

PORCUPINE.—The output of the producing mines continues to show a steady increase. The monthly statement of the Dome Mines for September shows a production of gold of the value of \$139,000 from the treatment of 28,500 tons of ore, of the value of \$4·88 per ton. The regular 4-weekly statement of the Hollinger for the period ended September 9, shows gross profits of \$149,935 from 28,172 tons of ore of the average value of \$9·03 per ton. Working costs were \$3·17 per ton milled, which is the lowest on record. In addition the mill treated 11,559 tons from the Acme mine. An important addition has been made to the ore reserves by the opening up of a new orebody of low-grade ore, 30 ft. wide, on the 200-ft. level. The McIntyre has made a new high record for the month of September, the gross value of the production from 8395 tons being \$70,268, and the profit \$32,723. The directors have completed arrangements for the purchase of the controlling interest in the adjoining Jupiter property for \$152,000, of which \$60,000 will be devoted to the liquidation of indebtedness, leaving \$92,000 for working expenses. Jupiter ore will be treated at the McIntyre mill. A rich orebody has been struck on the 500-ft. level of the McIntyre. The company is also carrying on operations at the Pearl Lake, where a cross-cut will be run at the 1000-ft. level to No. 5 shaft of the McIntyre, and a rise put up to connect with the shaft. At the North Thompson, cross-cutting on the 200-ft. level resulted in finding a vein 7 ft. wide, carrying $12 ore, which on being followed up widened to 23 ft. and improved in grade. A syndicate of Toronto capitalists, headed by Alex. Fasken, has taken an option on the Davidson property, which is being unwatered. A new orebody struck in the wall of the drift at the Imperial, about 8 ft. in width, has yielded some high assays. The assets of the Swastika Mining Co. have been purchased by Frank L. Culver and an associate. The mine was profitably worked on a small scale, but when heavily capitalized and expensively equipped, failed to meet operating expenses.

COBALT.—The silver mining industry is still handicapped by the low price of the metal, and bullion shipments are light, several of the companies preferring to store their output until conditions improve. The Nipissing during September mined ore of an estimated value of $178,848, and shipped bullion from Nipissing and custom ore of an estimated value of $120,976. Good ore has been exposed by the Cobalt Lake Co. at the 385-ft. level of their property adjoining, which will be developed on the Nipissing side of the line. Arrangements have been made with the O'Brien by which the Nipissing will use No. 14 shaft of that company for the exploration of their property, 40 acres in area, lying northeast of the O'Brien, on which hitherto only surface prospecting has been done. At the Beaver, diamond-drilling has proved the occurrence of rich ore at a depth of 1700 ft., and the shaft is being sunk to that level. If ore in paying quantities is found at that depth, it will have an important bearing on the life of other mines in the district. The old Silver Queen property is being operated by a force in charge of Manager Angus of the Right of Way, and high-grade ore is being extracted. The Rochester mine has been taken over by the Trethewey Mining Co., and some promising new orebodies have been discovered. The Shamrock is being operated by a new company called the Shamrock Consolidated, capitalized at $1,000,000.

KOWKASH.—The new goldfield continues to attract mining men, and a large area has been staked. A report by Percy E. Hopkins, Assistant Geologist of Ontario, is of a decidedly encouraging character. Since the report was published there have been numerous discoveries at various points in the Keewatin belt, proving the extended area of the field. The King Dodds property, on which the first discovery was made, has been taken over on a working option by a syndicate headed by John L. Orn, of Buffalo, and C. M. Forbes, of Lanark, Ont., and development is being actively pushed. The vein has been stripped for 300 ft., and a shaft is being sunk. Tellurides have been struck. A road to Kowkash Station, 8 miles distant, is being built to allow the transport of machinery. A number of buildings are being erected, and there is every indication of Kowkash becoming an important camp.

BOSTON CREEK.—This is a mining centre of growing interest situated about 53 miles north of Cobalt. A number of claims are controlled by John Papapassimakes, a Greek capitalist. On the principal of these, known as the Kenzie, a force of men has been at work throughout the season. A vein 12 in. wide has been stripped for 450 ft. and two shafts are being sunk. The ore extracted is rich in fine sulphides and assays high. A small plant will shortly be erected.

WEST AUSTRALIA.

WESTONIA.—At Westonia several encouraging developments have been recorded. The Edna May Co., owing to a heavy inflow of water in the cross-cut at the 300-ft. level, was compelled to stop the work. Bore-holes were put in from the end of the cross-cut and they pierced the lode at several points. Owing to the deviation of the bores, it is not possible to give the true width and value of the lode, but the results were such as to indicate that they will not be less than at the 225-ft. level. The Edna May company has distributed its monthly dividend of 3s. per share, absorbing £6427. This makes a total of 61s. per share, or £130,693 from ore extracted above the 225-ft. level, the amount being equal to nearly four times the original capital.

The Edna May Deep Level company announces that the Edna May lode has been cut in their ground by a diamond-drill bore at a vertical depth of 443 ft. The core shows the lode to average 120s. per ton over a width of 26 ft. The exact position of this bore-hole is causing considerable controversy in local mining circles. It was commenced at a depressed angle, and the point of intersection brings it near the corner peg of the Edna May, Edna May Central, and Deep Level leases. The Edna May people must accept the probability that they lose the lode at 400 ft., but whether the shoot of ore pitches to the west going into the Deep Level ground, or east into the Central lease remains to be proved by actual development. Should this work confirm the result of the diamond-drill holes, it will considerably enhance the value of this comparatively new goldfield.

It has already been suggested that the Edna May and Edna May Deep Level companies should amalgamate. The former has a mine well equipped with a power and treatment plant, now being considerably increased. It has ore reserves sufficient to last for several years, and is in a strong financial position. The Deep Level company will, if the bore-hole developments be confirmed, secure this lode at a depth of 400 ft., but its power plant will not be sufficient to cope with the heavy inflow of water when the lode is cut in their ground. And it has not any treatment plant. Under these circumstances it would be advantageous to both companies to amalgamate their interests. Had they been English companies, the matter would probably be easily arranged. But directors in the Eastern States have been accustomed to small companies, and apparently prefer to use their mines for the share market rather than put them on a commercial basis to secure as much as possible for the shareholders in dividends.

WARRIEDAR-YALGOO.—This new mining district is reported to be opening up satisfactorily, and it is hoped that the options held by the Oroya Black Range company will be exercised. The chief trouble so far is the shortage of water, as at 150 ft. the water shaft is only making 3000 gallons per day. The auriferous lodes are mostly a compact heavy close-grained ironstone, often carrying a large percentage of asbestos. There are also numerous quartz veins, but with one or two exceptions they seem to be poor. A big jasper bar can be traced right across the main property, running approximately east and west, and as in other mining centres it certainly appears to enrich the lodes in its vicinity. The main lodes run north and south, but there are some east and west lodes and veins. Particulars as to the size and value of the lodes are naturally not at present available.

KALGOORLIE. — The mortgagees of the Chaffers company will offer that mine and plant for sale by auction on October 27, unless in the meantime the liquidator is able to secure private offers to cover the preferential claims of the men for wages and of the mortgagees. It is to be hoped that the mine will be taken over by some company prepared to develop it thoroughly. This is necessary before economical results may be expected. The western lodes cannot be counted on until they are connected with the surface, as under the present conditions mining costs would be far too high. It must be recognized that this is a low-grade mine, and that everything must be done with the utmost care and attention to expenditure to enable it to become profitable. From a lease adjoining the North End mine 80 tons has been put through the mill for a return of £2011; a previous crushing yielded £2910 from 76 tons. These crushings were taken from small lenses of ore characteristic of the northern part of the Kalgoorlie district, and in the vicinity of Hannan's Reward. Unfortunately there does not appear to be any continuity of these lenses either in length or depth. The most famous of these was that found on the Hidden Secret lease. Many thousands of pounds have been spent looking for another lens on this mine, but without success.

BIG GOLD HUNT.—A prospecting scheme under new conditions has just been launched. The main idea is that more systematic prospecting should be done, and the different parties should work under the supervision of an experienced prospector. A belt of country will be mapped out for operations, and a headquarters formed where an Assistant Government Geologist and an assayer will reside. The former will advise the prospectors, while the latter will assay a certain number of samples for each party. In this way the backers who are financing the various prospectors will have their interests protected, and both parties will have the advantage of free scientific assistance. The Mines Department are heartily supporting the scheme by lending camels for transport, and supplying the geologist and assayer.

The originator of the scheme, Mr. A. M. McIntyre, journalist and mine owner, has devoted time and money for many months arousing interest, finding backers, choosing prospectors, and performing many duties necessary in starting a work like this. The idea is an excellent one, and whether the big gold hunt is successful or not in opening new goldfields, Mr. McIntyre deserves the appreciation of those interested in the welfare of mining in Western Australia.

The first party of thirty prospectors has reached its line of attack, a belt of country between Forrestania, the new find near Mt. Holland and the Bremen ranges. They will gradually work south toward Ravensthorpe. It is hoped that another party will be formed to prospect a belt of country to the north of Laverton, between Weld range and Youanme.

PERSONAL.

O. GORE ADAMS, formerly director of the School of Mines, Thames, New Zealand, and now engaged in tin mining in Bolivia, is on a holiday visit to New Zealand.

H. DOUGLAS ALLEN left London on October 20 on his return to the Jantar mine, Naraguta, Northern Nigeria.

W. R. COLERIDGE BEADON has left Kolar, India, for London.

G. H. BLAKEMORE has left Sydney for Vancouver, on his way to London.

A. A. BOYD, who has been acting general manager of the Mount Morgan company since May last, has had the appointment confirmed.

R. GILMAN BROWN and D. P. MITCHELL have returned from Siberia.

J. W. BRYANT has returned to London from Russia.

COLIN CAMPBELL is here from Rhodesia.

CAMILLO CERRUTI has been inspecting the anthracite beds of Val d'Aosta, Italy, and he is now preparing to make a study of the lignite deposits of Tuscany.

J. PARKE CHANNING is in Arizona.

WILLIAM F. COLLINS is here from Peking.

WILLIAM F. COLLINS left on October 20 for the Filani company's tin properties at Naraguta, Northern Nigeria.

G. D. DELPRAT has relinquished control of the smelting plant at Port Pirie, lately transferred to the Broken Hill Associated Smelters company, and the general management will be in the hands of William Robertson.

F. M. DICKENSON, secretary of the Broken Hill Proprietary, has gone to the Far East on business for his company.

E. J. Q. DICKSON is here from Mexico.

JAMES DOUGLAS has been elected Chancellor of Queen's University, Kingston, Ontario. He has offered $150,000 toward a fund for building residences for students attending McGill University, Montreal.

JOHN A. DRESSER has severed his connection with the Lake Superior Corporation, and will practice as a mining engineer with offices at Montreal.

A. E. DRUCKER expects to leave La Salada mine, Colombia, about the end of November, having completed the new cyanide plant for the Frontino & Bolivia Mining Company.

ANDRE P. GRIFFITHS, manager of the Dos Estrellas mines at El Oro, Mexico, has returned to England.

H. C. HOOVER is in New York.

J. P. HUTCHINS is back in Petrograd from a trip through the Caucasus and into Siberia.

WILLIAM R. JONES has received the degree of D.Sc. from London University for his thesis on the origin of tin deposits.

A. E. KITSON, Director of the Geological Survey of the Gold Coast, has returned to West Africa, and expects to remain there until June.

D. H. LADD has returned to Michigan after a visit of several months to London.

J. V. LAKE has left the Babilonia mine, Nicaragua, for Australia, on holiday.

J. H. LANGLEY has been appointed Inspector of Mines in the South-West Africa Protectorate with head-quarters at Windhoek.

V. F. STANLEY LOW has left Australia for South Africa, and after a short visit there, intends to come to England.

VAN. H. MANNING has returned to Washington from California.

PERCY MARMION is manager of the Swansea Vale smelter.

ROLF MARSTRANDER is in northern Uruguay examining possible coal and oil fields for the Instituto de Geologia y Perforaciones.

EDWARD T. MCCARTHY is visiting the mines of the Spassky company in Siberia. He went to Atbasar in October after the snows had begun.

MALCOLM S. MOORE has come from Australia to undertake war work.

C. H. OLIVER left England on October 27 for the Abbontiakoon mine at Tarquah, West Africa.

ERNEST V. PEARCE has left for New Jersey to take charge of the new tin-smelting plant of the American Smelting & Refining Co., at Perth Amboy.

WALTER G. PERKINS left on October 16 for New York.

E. DAVID POPE has joined the staff of the Société des Mines de Cuivre de Catemou, Chile, and is designing a new concentrating plant at the Soldado mine.

GEORGE S. RICE has returned to Pittsburg after a long trip through the western states for the United States Bureau of Mines.

J. H. RICH has left Cornwall on his return to the Tronoh mine, Perak.

HAROLD RICKARD has obtained a commission with the Royal Engineers.

JAMES COLE ROBERTS, of the United States Bureau of Mines, Denver, has been appointed to the Joseph Austin Holmes Professorship of Safety and Efficiency Engineering, in the Colorado State School of Mines, at Golden, Colo., and assumed his duties on November 1.

H. V. SEALE, of the Junction North mine at Broken Hill, has joined the Australian expeditionary force.

HAROLD SHARPLEY is here from South Africa.

W. E. SIMPSON has returned from Mexico, and is now in Scotland.

J. M. STOKES, lately with the Zinc Corporation, has been appointed secretary of the Broken Hill South Silver Mining Co., Adelaide.

W. TRURAN has returned to London.

SCOTT TURNER is expected in London after his usual summer campaign in Spitzbergen.

CHESTER W. WASHBOURNE has returned from Angola, and will be in Portugal for several weeks.

D'ARCY WEATHERBE is expected from Cobalt, Canada.

S. WEBB-BOWEN is in London from Nigeria.

T. WEIR has returned from the property of the Ex-Lands Nigeria company's property at Narkarn, Jos, Nigeria.

AMONG the mining engineers at the front are several members of the staff of the El Oro Mining & Railway Co. Two of them, Lieut. G. A. SYME and Lieut. O. D. FILLEY, have already won the Military Cross. Lieut. FILLEY is in the Royal Flying Corps, and won his cross as the result of an encounter with an enemy aeroplane under peculiarly difficult and dangerous circumstances.

THE firm of BRUCE MARRIOTT & CO. and its staff are doing well for the country. T. BRUCE MARRIOTT has a commission with the Royal Engineers, HAROLD MARTIN is also with the Royal Engineers, GEORGE GONSALVES is with the Army Service Corps, G. P. CHAPLIN is in the Royal Garrison Artillery, and E. G. BOWDEN is with the Queen's Royal West Surrey regiment. The professional work of the firm is left in the hands of W. F. A. THOMAE.

PRECIS OF TECHNOLOGY

[Copies of the original papers and articles mentioned under this heading can be obtained on application to the Technical Bookshop, Salisbury House, London, E.C., the book department of The Mining Magazine.]

Geology of the Waihi Grand Junction.—In a paper presented at the October meeting of the Institution of Mining and Metallurgy, Arthur Jarman gave the results of geological studies at the Waihi Grand Junction mine up to June 30 last. It will be recalled that in their report upon the Waihi district, Bell and Fraser put forward the tentative conclusion that the more important orebodies were associated with, and largely confined to, an intrusive phase of the dacite younger than the main body of bedded dacite. They did not attempt to draw a detailed boundary between the two dacites, leaving that for the geologists of the individual companies, and it is far from certain that they considered their conclusion to be more than a working hypothesis. It has, however, been very generally accepted by geologists outside the district. As it imposed severe restrictions on the probable field for prospecting on the part of his company, Mr. Jarman has made a special study of this particular matter. With the general conclusions of Bell and Fraser as to the geology of the district he is apparently in accord. He finds no more than negative evidence to favour the hypothesis of an intrusive dacite, and advances positive evidence to the effect that the whole mass is one thing, a series of extrusive flows. Accordingly no boundary is to be drawn between flow and plug, and the making of ore in the lodes is imputed to the favourable or unfavourable character of the particular part of the dacite that forms the wall-rock. In general hard walls favour ore formation here. The whole mass, as is well known, has been extensively propylitized, part of the dacite has been silicified, and exact relations are by no means always clear. Briefly, Mr. Jarman finds flow structure within the area of the supposed intrusive, if not frequently at least in all parts; he finds no evidence of metamorphism along the supposed line of contact, nor indeed any clear contact; partings and flow direction, when determined, conform almost entirely with similar phenomena in the admitted bedded portion of the dacite surrounding the supposed intrusive; the ground mass of the intrusive is never crystalline; the phenocrysts are those characteristic of dacite flows; the supposed absence of coaly parting in the intrusive is not complete and also many of the supposed coaly partings contain very little carbon, being black mainly because of admixture of sulphides. These conclusions are discussed editorially.

Standardizing Rock-Crushing Tests.—At the September meeting of the American Institute of Mining Engineers, Myron K. Rodgers presented a paper containing the standard specification relating to rock-crushing tests, suggested by the Institute's committee on milling methods. This specification was submitted for discussion, criticism, and advice on the part of both members of the Institute and others.

Reports of rock-crushing tests should give the following details: (1) Description of the machine employed, whether jaw or gyratory crusher, rolls, stamps, tube-mill, or chilean mill; (2) method and material of foundation, whether timber, concrete, etc.; (3) locality from which the rock or ore was obtained, and geological, mineralogical, and physical characters of the material; (4) power consumption of the machine running with no load and with full load, the unit of power being one horse-power per day of 24 hours; (5) the capacity of the machine in tons of 2000 lb. per 24 hours; (6) duty in tons per horse-power-day; (7) screen analysis of feed and product by the proposed Institute standard screen scale.

For screen analysis it is desirable to have a series of screens with a uniform ratio between their apertures. The series proposed by the Institute's committee is based on a wire screen having 200 holes to the linear inch, each hole being 0·0029 in. wide and the wire 0·0021 in. diameter. The widths of the holes of successive screens are calculated, according to Rittinger's system, so that the area of the holes in one screen shall be double that of the holes in the next; that is to say the successive widths shall be in the ratio of $\sqrt{2}:1$. The following table gives details of the screens:

Holes per inch	Width of holes Inches	Diameter of wire Inches	Area of holes Sq. In.
	4·20	0·375	17·64
	2·97	0·207	8·82
	2·10	0·192	4·41
	1·49	0·149	2·20
	1·05	0·149	1·10
	0·742	0·135	0·551
	0·525	0·105	0·276
	0·371	0·092	0·138
3	0·263	0·070	0·069
4	0·185	0·065	0·034
6	0·131	0·036	0·017
8	0·093	0·032	0·0086
10	0·065	0·035	0·0042
14	0·046	0·025	0·0021
20	0·0328	0·0172	0·00108
28	0·0232	0·0125	0·00054
35	0·0164	0·0122	0·00027
48	0·0116	0·0092	0·000135
65	0·0082	0·0072	0·0000672
100	0·0058	0·0042	0·0000336
150	0·0041	0·0026	0·0000168
200	0·0029	0·0021	0·0000084

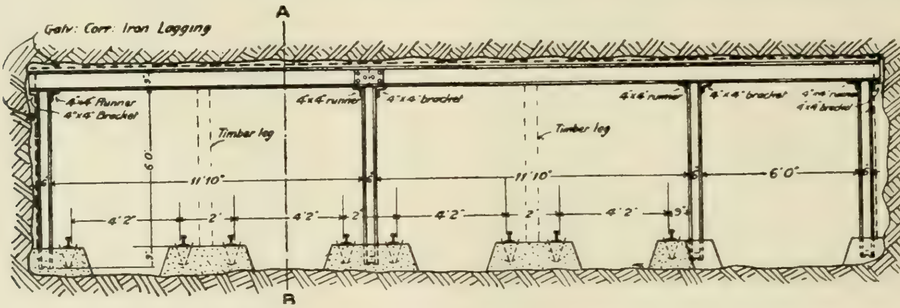
The 200-mesh screen is the finest used in ordinary investigations, but 260-mesh is employed in flotation tests and in connection with cement manufacture. A screen fitting the new series would have 280 holes per linear inch, each 0·002 in. wide. We discuss this standard screen scale in our editorial columns this month.

Underground Fires.—A circular has been sent to mine owners in the United Kingdom by Sir R. A. S. Redmayne, Chief Inspector of Mines, drawing attention to the dangers that may arise from a fire in an underground engine house or other underground room. The specific case quoted in the circular was the fire that occurred in an underground engine house at Hem Heath Colliery, North Staffordshire, on February 25 last, which resulted in the loss of 12 lives. The engine house in this case was constructed of brick side walls, on which iron girders were placed to support the roof. Between the girders were wooden poles, and the whole of the roof was lagged with timber. The engine rested on four wooden beams, and the floor was boarded over at the sides and back of the engine. Compressed air was the motive power, and the exhaust was taken below the floor boards. Brick pedestals were built from the floor under the valve chests, and on them were placed paraffin oil stoves to prevent freezing in the exhaust pipes. The floor of the engine house, beneath the boards, was covered with water to a depth of about 9 in., and on the surface of this water a film of oil had accumulated. The engineman, according to the evidence given at the inquest, was filling one of the stoves with paraffin oil while it was lighted, and for this purpose used an old tin. By some means he accidentally upset the stove and the oil in it, and the oil on the top of the water burst into flame, with the result that the flooring boards were also set on fire. The engine house was built directly under an air crossing, over which passed the return air from the greater portion of the workings. The crossing, being constructed of wood, became involved in the conflagration, with the result that it was impossible to reverse the air without imperilling the lives of all the men in the mine, and preventing anyone reaching the fire.

This accident, following the similar disaster which occurred through a fire in an underground cabin at the Cadder colliery in August, 1913, emphasizes afresh the great danger that attends the use of wood and other material in the construction of underground engine houses and underground rooms generally. The only method of dealing with the danger is the elimination of inflammable material from the structure of such rooms. So far as new construction is concerned the Act prohibits the use in engine houses of any inflammable material likely to cause danger of fire, and the Inspector urges on owners and managers of all mines the desirability of removing, as far as possible, inflammable material in the case of any existing engine houses or other underground rooms, and of using non-inflammable material only in all such houses or rooms.

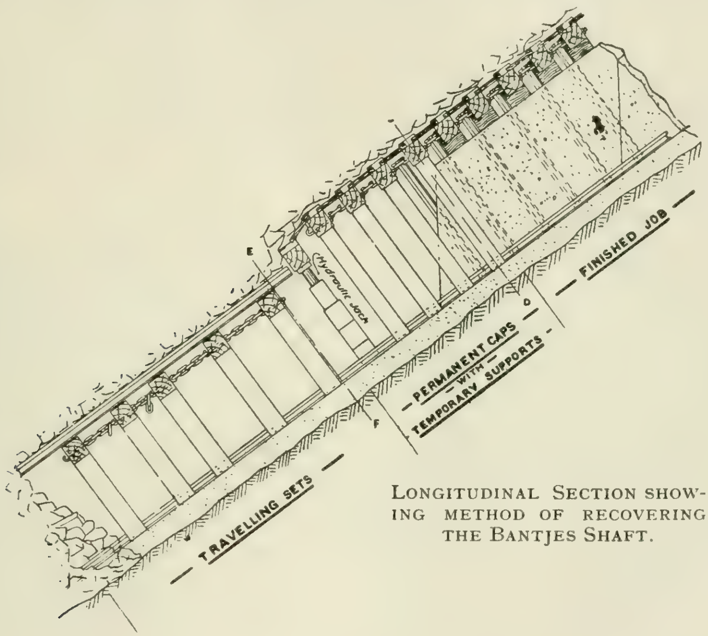
Petroleum in Portuguese East Africa.—In the *South African Mining Journal* for September 11 and 18, J. E Mills Davies refers to the chances of finding petroleum in South Africa. He quotes Mr. Cunningham Craig's classic report on the absence of prospects in the Union. As against this he refers to the long strip of Cretaceous rocks along the coast of Portuguese East Africa, extending into Zululand on the south and into German East Africa on the north. On the other side of the Mozambique Channel, the west coast of Madagascar consists of Cretaceous and Jurassic beds that are known to be petroliferous. The low-lying coastal plains of Portuguese East Africa are so covered with recent deposits and overgrowth that prospecting is difficult. Mr. Mills Davies takes it that the Cretaceous beds of the continent and Madagascar are part of the same deposit, and that they were at one time continuous through the Comoro islands which lie at the north end of the Mozambique channel. He is of opinion that confusion has arisen in many quarters as to the nature of the bituminous occurrences at Lake Nhangela in Portuguese East Africa, owing to the presence of a substance called nhangellite. This substance is a sort of fossil seaweed, and as the theory that petroleum may be derived from sea-weed is now out of date, the deposits at Lake Nhangela became neglected. Mr. Mills Davies shows that the bituminous material has no connection with nhangellite. He quotes records of bituminous material yielding oil at the rate of 102 gallons per ton, and is of opinion that further exploration is desirable.

Recovering the Bantjes Shaft. — The September issue of the *Journal* of the South African Institution of Engineers contains a paper by Percy Cazalet and W. W. Lawrie, describing the collapse of the Bantjes shaft in December last and the method of recovering it. At this mine, there are three shafts, all inclines, and it was the Central that collapsed. The roof fell for 95 ft. at a distance of from 125 ft. to 220 ft. from the surface. The shaft is inclined at 34½° with the horizontal and passes from the foot-wall of the South Reef to the hanging wall at about the middle of the collapsed part. The strike of the reef is east-west. A wide dike with northeast — southwest strike and a dip of 45° southeast displaces the reef. The shaft is sunk under and nearly parallel with the dike. The rocks are oxidized and decomposed down to 220 ft. on the incline, and it was this class of rock that collapsed. Owing to long and heavy rains the decomposed dike-rock had become waterlogged and assumed the consistency of plastic mud. The weight of this mud pressed upon the bed of sandstone forming the roof of the incline and caused it to collapse. The walls and the floor of the shaft were not injured. The shaft measures 33 ft. by 7½ ft. and is divided into five compartments, containing four skipways and a ladderway. Steel setts are used, as shown in the diagram, and the rails are bolted to concrete stringers. The setts were not designed to support the roof so much as to carry lagging and so prevent loose pieces of rock from falling into the skipways. At the point of contact of the oxidized and unoxidized rock, the setts had been duplicated, as trouble was naturally anticipated there. The roof collapsed with practically no warning, and the steel setts were buckled in all directions and brought down to the rails. In considering the question of recovery of the shaft, the first work to be done, in order to prevent the mine from being flooded, was to repair the damage done to the cables and mains passing down the ladderway to the pumping station on the 10th level. A winze, 85 ft. deep, was sunk from above the collapsed part to the first level, and another, 20 ft. deep, from the first level to the shaft below the collapse. The cables and mains were connected through this alternative route, and the pumps were re-started 10 days after the fall. The recovery of the two eastern skipways was then undertaken, and the recovery of the other two skipways was postponed until the dry season later. This arrangement was possible owing to the shaft being larger than required for the present scale of operations. It was obvious

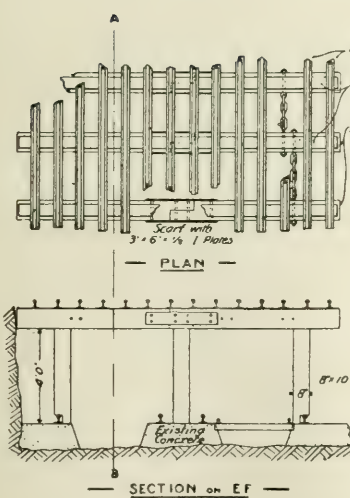


CROSS-SECTION OF BANTJES SHAFT, BEFORE COLLAPSE OF ROOF.

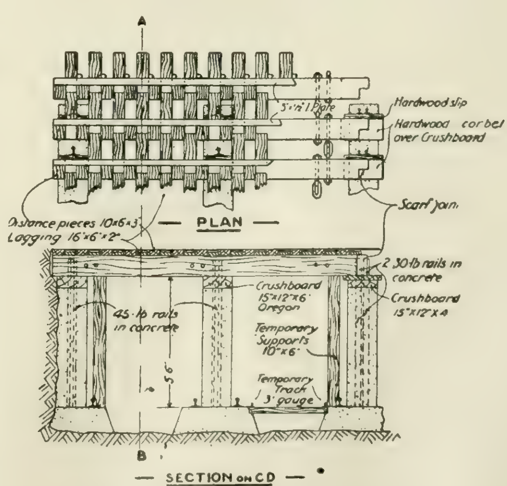
that the collapsed part could not be attacked from the bottom, as the removal of the sandstone might result in an inrush of mud. That such a policy would have proved fatal is shown by the fact that on recovery from the top the caving extended to the surface of the ground. The removal of the twisted steel was done by means of an oxy-acetylene lamp. The rock as removed, beginning from the top of the collapsed part, was passed through a pipe placed along the channel between two concrete stringers. It was possible to place this pipe here, as the steel girders and steel lagging resting on the rails and concrete stringers formed a protective cover. The supporting of the roof before and during the removal of the fallen rock was done on a system similar to that applied to tunnelling in soft ground. Five travelling setts of timber, carrying 15-ft. lengths of 45 lb. rails constituted an advanced casing. The rails were driven into the broken ground by 14 lb. hammers. The legs of the setts were 3 ft. 6 in. high, and the caps 10 in. square by 14 ft. long. The setts were tied together by chains. The top of the caps were covered by thin steel plates to prevent friction, and pegs were inserted so as to keep the rails at proper distances apart. As the advanced setts progressed permanent caps and lagging were put in place on temporary supports, the roof being forced upward by a



Longitudinal Section showing method of recovering the Bantjes Shaft.



Details of Travelling Sets and Rails.



Plan and Cross-Section of the completed work.

hydraulic jack. The permanent caps were at first supported by timber dividers, but it was found that the caps had a tendency to travel down the shaft, being forced in that direction by the pressure above. Subsequently concrete walls were employed, and though these also at the beginning behaved in the same way, they ultimately gave great satisfaction. The authors give full details of the construction of the concrete walls.

The Newnam Hearth.—The October *Bulletin* of the American Institute of Mining Engineers contains a paper by William Newnam describing his improved form of the ore-hearth used for smelting high-grade non-argentiferous galena. Mr. Newnam is superintendent of the St. Louis Smelting and Refining Co. The ordinary ore-hearth has few applications nowadays, for several reasons. It cannot be built more than 4 to 5 ft. long; the amount of labour required is large and the work very hard; moreover, much fume and dust is produced. Two men are required per 8-hour shift, and the work of rabbling is hot and laborious. The advantages are that a large proportion of the lead is immediately reduced, and that the remainder is obtained in a slag in the form chiefly of sulphate and oxide, an ideal product for the blast-furnace. Mr. Newnam undertook experiments with a view to improving the conditions. The first thing to be done was to design a cool and sanitary hood, and he soon devised a double hood that gave the room a fume-free atmosphere, at the same time reducing the amount of heat directly radiated on the men. The next was to provide a lead-well attachment that will mould clean lead direct from the hearth basin with little attention on the part of the men. To obviate hand labour in rabbling, a travelling rabbler was invented. This is suspended from a carriage running on an overhead track. The rabble is operated and moved forward automatically. A helper is required to follow behind the rabble arm, to push back the loose charge and pick out the grey slag. Behind him is a man, the charger, who spreads a thin layer of ore on the charge as fast as it is shovelled back by the helper, adding coke breeze as needed. By means of this machine it is found possible to use a hearth 8 ft. long. This produces two-and-a-half times as much lead as the hand hearth, and the two men can operate it with much less fatigue than the old smaller hearth. The amount of fuel used has also been substantially reduced. As the furnace is not open so long, a smaller amount of dust and fume is produced.

Petroleum Industry of Mexico.—The first meeting of the Institution of Petroleum Technologists, for the winter of 1915-16, was signalized by the presentation of a comprehensive paper on the above subject by P. Charteris A. Stewart, who is associated with Lord Cowdray's enterprises in the country mentioned. After describing the topography and climate of Mexico, emphasizing the fact that the petroleum fields are in the tropical portion of Mexico, he discussed briefly the geology, bringing out the points that the main pools are found in the Tamasopo, a deeply buried Cretaceous limestone, which has a maximum thickness of 20,000 ft. The field is cut by dikes and punctured by volcanic plugs, and it has been argued that the petroleum is, if not genetically related to them, at least accumulated in structures due to the intrusions. Mr. Stewart brought out the facts that not all the intrusions have pretroleum associated with them, that intrusions occur down the structural slopes, and in synclines as well as underdomes, and stated the conclusion that the structure antedated the intrusions. In discussion he also mentioned that experience had indicated that when, in drilling, the temperatures rose especially rapidly the well was already too deep. In drilling, both rotary and standard rigs are used, and the cost is about equal, the rotary losing on labour cost what it gains on speed and less casing. The best rig is a combination, but to get full advantage the combination must be available from the first. The under water pipes for loading 15,000 ton tank steamers were described, and it was stated that the method had proved successful save only in the most severe storms. With the later pipe-lines the whole line was screwed together on shore, supported on rollers on a temporary track at right angles to the shore line, and then dragged out to sea by means of a tug. Owing to absence of highways or of suitable rock for making them the companies have had to build light railways through the district. Oil is transported through pipe-lines, about 400 miles being in operation, save from the Panuco field where the viscosity of the petroleum is so high as to have made this impracticable so far. In the Northern Vera Cruz fields the tankage is listed as follows:

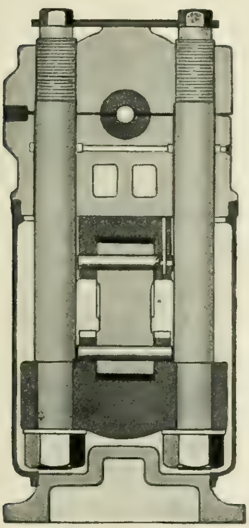
	Barrels.
Steel	16,500,000
Earthen	11,000,000
Concrete	1,250,000

Such progress has been made in refining as to overcome the early impression that Mexican petroleum was not adapted to the continuous process, and several plants are in operation. Asphalt is also being refined and shipped in large quantities. The present operations are summarized as follows: Wells producing, 93; abandoned, 32; drilling, 75. The life has been shown to be good, Pez No. 1 having flowed at least 9 years with a total production of 3,450,000 bbl. Pez 6 gave 1,763,612 bbl. in 4 years. Juan Casiano 7, which came in September 1910, had produced 38,000,000 bbl. up to June this year. Dos Bocas was probably the greatest well ever brought in, but, as is well known, proved uncontrollable. A severe rise in cost, due to increased taxation, has marked recent development.

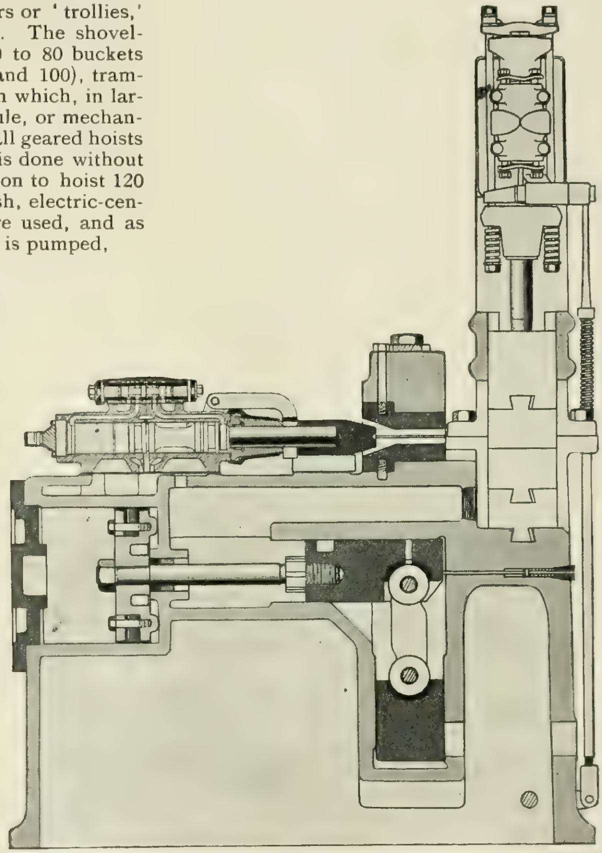
Sheet-Ground Mining at Joplin.—The larger low-grade zinc mines at Joplin, Missouri, are in a sheet of chert 150 to 250 ft. below the surface. The blende occurs along bedding planes in this chert in quantities sufficient to make the crude ore yield 2 to 3% in tonnage of zinc concentrate. While the body of chert is approximately 50 ft. thick the mineralized portion is usually 6 to 8 ft., ranging up to 20 or 30. This is 'sheet-ground' and the methods of mining it are those adapted to working horizontal bedded deposits. These methods were described before the Lake Superior Mining Institute by Edwin Higgins, of the United States Bureau of Mines, and reported in the *Mining and Engineering World*, October 2. The shafts, being shallow, are numerous and small. The ground is opened from one or more sides according to the position of the ore, and the face is carried forward in an irregular expanding circle. The roof is supported by pillars 15 to 20 ft. in diameter and 40 to 60 ft. apart. These are left in rows 'staggered,' where it is not possible to take advantage of lean spots. The ground is drilled by machine drills, usually with solid steel, and compressed air at 60 to 90 lb. pressure. The face is kept irregular as in shooting coal 'off the solid' and so as to give a free face for breaking. In ground 7 to 18 ft. thick each machine drills 20 to 35 ft. and breaks 35 to 45 tons. With a high face the advance is usually along the roof, the stope being shot up by means of 'splitter' and 'stope' holes. In a few places this has been reversed with a resulting saving in cost. The cost of explosives is high, constituting 20 to 30%

of the total. A box (50 lb.) of powder (ammonia or gelatine 33 to 40%) breaks 30 to 45 tons. The holes are usually chambered or 'squibbed' before final shooting. A convenient method of doing this is to carry one round of holes ahead and squib at the end of one shift, shooting at the end of the next. Virtually no timber is used and the ore is shovelled from the heap into buckets or 'cans' of 1000 to 1650 lb. capacity which are run on low flat cars or 'trollies,' usually by hand, to the hoisting shaft. The shovellers are paid by the can, and load 30 to 80 buckets per 8-hour shift (with records of 90 and 100), tramming each to the shaft or switch, from which, in larger mines, they are taken by hand, mule, or mechanical haulage. Hoisting is done by small geared hoists set in the top of the head-frame, and is done without cross-heads or signals, and it is common to hoist 120 buckets or more in one hour. Cornish, electric-centrifugal, and steam plunger pumps are used, and as much as 1500 gal. per minute of water is pumped,

The forming and upsetting hammers are operated by rock-drill cylinders fitted with Sullivan air-thrown differential or spool valve motion. The horizontal hammer has on the end inside the cylinder a floating piston and a loose shank or distance-piece to receive the blows of the piston, and a blank at the front end to receive a loose dolly. The vertical hammer has an



Cross-Section through Vice.



Sullivan Drill-Sharpener.

Sullivan Drill-Sharpener.—*The Engineer* for July 16 contains a description of a perfected form of machine for forming and sharpening drill-bits, placed on the market by the Sullivan Machinery Company, of Chicago. The work of the machine, including forming, upsetting, and operating the holding-vice, is done entirely by compressed air. As shown in the illustration, the forming hammer is held in a vertical frame, with the anvil below made as part of the pedestal. The upsetting hammer is mounted horizontally and the vice for holding the steel up to it is in the position in front of it, as in the illustration. This vice consists of an upper and a lower jaw, the latter being cast with the pedestal, and the upper being held by two rods which pass downward through the lower jaw and are connected by means of toggle-joints with the piston of the large air cylinder. The upper and lower jaws carry the dies required to make any particular form of drill-bit. By means of this mechanism, the upper jaw of the vice is brought down to clamp firmly the drill in position in front of the upsetting hammer. ordinary rock-drill piston and piston-rod, to the end of which is fitted a guide-block which carries the upper of two square forming or swaging dies. The lower die is keyed to a similar anvil or block that rests on the frame. This hammer is operated by a foot pedal, but the vice and upsetting hammer are worked by hand lever. It will be seen from the foregoing description that the upsetting is done by hammering action and not by squeezing. The process of sharpening is therefore of the same nature as the handwork of a skilled blacksmith, and the temperature employed is lower than in the squeezing process. The use of the vice does away with the tail-block often employed on sharpeners. We would add that the development of efficient sharpening machines has been long and tedious. Now that their advantages are appreciated they are being made and used in many countries.

Draining Flotation Tailing.—In the *Mining and Engineering Review* for September, W. Shellshear has a paper entitled 'Methods of Handling Waste Products from Mills,' in which he describes the various methods adopted at Broken Hill for de-watering and disposing of the tailing from flotation plants. Three methods are in vogue, and Mr. Shellshear suggests a fourth. It is advisable to recover as much water as possible and keep a closed circuit of liquor in order that oil shall not be wasted. The methods employed are: (1) Filtering in vats, (2) combination of submerged draining belt and Dorr thickeners, and (3) combination of Caldecott cones, draining belt, and Dorr thickeners; and Mr. Shellshear's proposed method is a combination of Dorr classifiers and Dorr thickeners.

In the first method the vats are usually arranged in a series so that the tailing can be continuously delivered direct to one or other of them, one filling, one emptying and the others settling. The vats are usually 15 ft. diameter, and from 10 to 20 ft. high. At the centre of the bottom of each vat is a circular discharging hole 15 in. diameter, upon which fits, during the process of filling, a vertical pipe of the same diameter. The bottom of the vat has drainage holes and is covered with cocoa matting. In order to discharge the vat, the central pipe is raised by screw block and block and tackle. If the vat is high it may be advantageous to make the pipe in two or more sections and to raise one at a time. Some of the de-watered tailing falls down the hole on the removal of the pipe, and the rest is afterwards shovelled down. It falls on a conveyor belt which takes it to the dump. Two advantages gained by this method are that the percentage of moisture left in the tailing is less than by any other method, and that the slime and sand are not separated. Having the slime and sand mixed means that the tailing heaps stand firm and that the surface is cemented, thus preventing dust and allowing more tailing to be placed per unit of ground area. On the other hand the initial cost and the cost of labour are high, and the clarification of the solution is not usually so complete as with the other methods.

In the second method the tailing is delivered through a distributer on to a travelling belt, which is submerged in water and bent to circular trough shape by being passed over a spherical pulley. The belt travels for a certain distance under water. During its progress the slime is eliminated and passes by the overflow to Dorr thickeners. As the belt emerges from the water and rises at a slope of 15 to 20°, the water is drained from the sand, which is eventually removed from the head pulley by iron scrapers. A bumping action is given to the belt from underneath by means of an idler driven by eccentrics, the effect being to dislodge a greater proportion of the water. This method involves the use of little attendance, but the life of the belt is shortened by its being bent and being submerged in hot liquor.

The third method has been adopted at the latest flotation plant erected at Broken Hill. Two Caldecott classifying cones are used, each 12 ft. diameter and 10 ft. deep, with the diaphragm 2 to 2½ ft. from the bottom. The thickened sand is discharged on to draining belts, and the slime overflow goes to Dorr thickeners. This has the advantage that the life of the belt is longer than with the second method, but more head-room is required.

The fourth method has not yet been adopted at Broken Hill, but as it is a standard at American cyanide plants, its application to Broken Hill tailing should be worth while. The tailing is delivered to Dorr classifiers, and the slime overflow to a Dorr thickener. The classifier would have to be made longer than usual so as to give an extra chance of draining for the sand product.

Mr. Shellshear's article includes also a description of the various methods of transporting the drained tailing to dumps and dams.

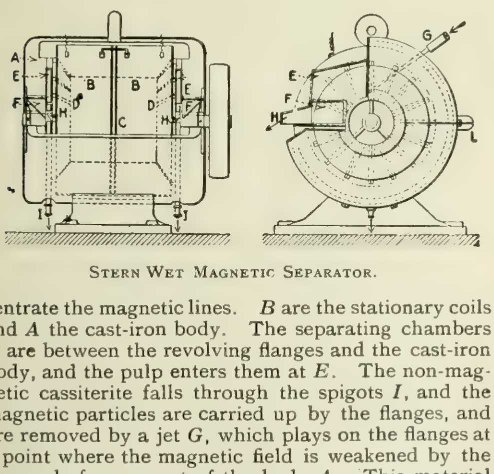
Economics of Zinc Metallurgy.—In a paper read before the International Engineering Congress at San Francisco and reported in the *Engineering and Mining Journal*, October 2, W. R. Ingalls discusses the present status of zinc smelting in Europe and America, pointing out the changes that have followed the introduction of Broken Hill concentrate. The latter, affording a large and assured supply of uniform grade, served to stabilize the industry and standardize European practice. In America the constant effort is to save labour; in Europe the development has been toward saving fuel. European smelters distil at higher temperatures than do those in the United States, use better retorts, build stronger furnaces, and make a slightly better saving by using prolongs to bring down blue powder. They, however, make a leady spelter that requires refining. The Europeans, spurred by the need of saving fuel, have been more receptive toward new types of roasting furnaces, and can dead-roast blende with a coal consumption of only 10% of the ore. Speaking generally, "per ton of raw sulphide ore the American smelter uses about 2 to 2½ tons of coal and 2 to 3 man-days of labour, and extracts about 87 to 88% of the zinc; if he treats lead-bearing ore he may recover 50 to 60% of the lead. The European smelter uses about 1¼ to 1¾ tons of coal and 3 to 3½ man-days of labour, and extracts 88 to 90% of the zinc in his ore and about 50 to 70% of the lead."

Hydro-Electric Metallurgy.—Electro-chemical and electro-metallurgical possibilities of the Pacific coast are discussed in *Western Engineering* for October by J. W. Beckman, chemical engineer for the Great Western Power Co. This company, he states, has 600,000 hp. capable of development within easy reach of tidewater and can furnish power, in suitable amounts, at prices that make even fixation of atmospheric nitrogen commercially feasible. He believes that numerous industries can and will be established in California and neighbouring states, where only from 3 to 8% of the 11,500,000 hp. available is as yet developed. He mentions as among those most easily to be established the manufacture of caustic soda, potassium chlorate, calcium carbide, nitrogen fixation, iron and steel industries, aluminium reduction, and probably miscellaneous smelting extending even to lead, zinc, and copper.

A Mexican Cyanide Plant.—The La Lucha cyanide plant is described in the *Mexican Mining Journal* for May by T. E. Pratt, and is commented on by the editor as the mill without an elevator. Throughout the plant air lifts are used, a plan which was the easier seeing that, except at one point, only slime needed to be elevated. There is a short lift from the tube-mill discharge to the feed of its own classifier. To mining men generally the La Lucha is of interest from the circumstance that it has been built during the Mexican revolution. The contract was let in August 1913, and stamps began to drop on July 5, 1914. In the first four months, operating at half capacity, the mill treated 4624 tons at a total cost of $88,096 and a profit of $106,250, a feat in management, having in view the conditions in Mexico, quite worth noting. The ore is crushed by breakers and stamps to 6-mesh, re-ground in a tube-mill in circuit with a Dorr classifier, after which the pulp is thickened, agitated, and finally treated in Merrill slime filter-presses. Precipitation is on shavings in zinc-boxes. The interesting feature of the construction was the use of built-up battery-posts

12 by 26 in., and 22 ft. long. These were made of selected 1 in. plank, planed, painted, and bolted together. The result has been entirely satisfactory.

Magnetic Separation at Llallagua.—In the *Engineering and Mining Journal* for September 25, D. Copeland and S. E. Hollister give particulars of the magnetic separator employed at the Llallagua mines, Bolivia, for separating pyrite from tin in the jig and table middlings. The tin ore at these mines contains an increasing proportion of pyrite. Fuel is scarce, so dead-roasting followed by re-treatment by wet concentration is not economical. A system has been devised whereby the sulphur content is used for supplying sufficient heat to magnetize the rest of the iron sulphide, and the magnetic particles are afterward removed by the Stern wet separator. It is found best to arrange for a middling averaging 25% sulphur, and to roast so as to give a product containing 10 to 12% sulphur. On sending this product through the separator, a non-magnetic concentrate is obtained containing about 68% tin, with 2% of sulphur, and 3% of iron, while the magnetic material averages 22% sulphur, 50% iron, and 3 to 4% tin. The magnetic material is re-ground and re-treated on tables for the recovery of the enclosed tin. The Stern separator is shown in the accompanying sketch. The revolving iron core *C* has flanges *D* bevelled at the edges to concentrate the magnetic lines.



Stern Wet Magnetic Separator.

B are the stationary coils and *A* the cast-iron body. The separating chambers *F* are between the revolving flanges and the cast-iron body, and the pulp enters them at *E*. The non-magnetic cassiterite falls through the spigots *I*, and the magnetic particles are carried up by the flanges, and are removed by a jet *G*, which plays on the flanges at a point where the magnetic field is weakened by the removal of a segment of the body *A*. This material is removed at *H*. The separating chambers are kept sufficiently full of water to cause a constant overflow at *L*, in order that the water may retard a rapid fall of the feed through the magnetic field. During the passage of the flanges out of the water, the particles clinging to them are rolled over, and thus any imprisoned non-magnetic material is released.

Porcupine Ore Deposits.—In a paper in the *Canadian Mining Journal* for October 1, A. R. Whitman, geologist for the McIntyre Porcupine Mines Ltd., discriminates five chief structural types: (1) The dome type, as already described by C. D. Kaeding, resembles a pear or plum on end with the large portion uppermost. The structure appears to be the result of localized strains irregularly affecting the mass of the rock so as to make it permeable to the ore-bearing solutions. These 'plums' of ore 100 to 200 ft. wide and as much as 400 ft. deep, occur in a mineralized belt near a contact between a boss of quartz-porphyry and the Temiskaming sediments. (2) The lode type is illustrated by the Hollinger ores which are found in tabular masses formed by replacement along zones rendered permeable by tension strains. (3) Fissure veins, meaning in this instance not a crustified deposit formed in an open space, but one formed along a definite thrust fault by replacement of the hanging wall, are represented by the McIntyre No. 5 vein. (4) Contact veins are illustrated in the Porcupine Crown where the ore follows approximately the contact of a quartz-porphyry stock with the older volcanics. It is tentatively believed to represent a tension rupture due to contraction incident to the cooling of the intrusive. (5) The contact lodes are represented in the McIntyre 'contact vein.' This is a mineralized zone along the contact of the basaltic schists with the south wall of the quartz-porphyry stock underlying Pearl lake. Like the Hollinger lode type, there is a general tendency to conform to the schistosity. The conformity of these ores to the older structures in the rock and the banding of the ores without crustification are interpreted as proofs of origin through replacement. This is confirmed by the finding of a thin sheet of ferro-dolomite between the walls of schist and the quartz, and the process of replacement is discussed.

Kowkash.—Information regarding this new Canadian district is given in some detail in articles by C. G. Hopkins and Charles Spearman in the *Canadian Mining Journal* for October 1. There is also now available an excellent preliminary map of the region published with most commendable promptness by the Ontario Bureau of Mines and embodying both Mr. Hopkins' recent observations for the Bureau, and earlier information derived from surveys by it and the Canadian Geological Survey. Mr. Hopkins' official text is not yet available, at least in England, but the main points are covered in his paper in the *Canadian Mining Journal*. His notes relate mainly to the geology. Mr. Spearman discusses in greater detail such matters as route, conditions of prospecting, and the circumstances under which E. W. King Dodds made the original discovery. Mr. Hopkins, as related in our Review last month, finds the geology similar to that at Porcupine. A belt of Keewatin rocks, 10 to 15 miles wide, extends in a northeasterly direction for nearly 40 miles. For miles this is surrounded by Laurentian granites and gneisses. The Keewatin rocks are largely massive, fine-grained, green chlorite and hornblende rocks, which are in part altered to schist. Some of this schist represents altered basalt, which may also be seen unchanged as pillow or ellipsoidal rock. Cutting the greenstones are numerous white-weathering quartz-porphyry dikes up to 30 ft. or more wide. These show white quartz phenoscrysts in a grey to green fine-grained groundmass. The porphyry, as at Porcupine, contains quartz stringers, and is schistose. Slates and conglomerates similar to the Temiskaming rocks are also present. Gabbro and diabase, probably the youngest rocks in the district, occur about 300 yards from the Dodds discovery. The Dodds vein conforms to the strike and dip of the country rock. The vein is lenticular up to 4 or 5 in. wide, and has been uncovered 40 ft. It consists of glassy quartz, largely free from sulphides, and showed spectacular gold over an area 5 in. long and one inch wide along the hanging wall. Similar and richer specimens were reported to have been taken from the 4 or 5 ft. adjacent. On the hanging-wall side is a rusty 6 inch band of schist mineralized with fine pyrite. A mineralized quartz-porphyry dike occurs near-by. A number of claims have been staked. There are numerous small veins of glassy quartz in the region, some being mineralized with pyrite, and Mr. Hopkins suggests the advisability of prospecting the whole

Keewatin area. Editorially the *Canadian Mining Journal* says, in comment on the papers by Messrs. Hopkins and Spearman, that while neither shows an inclination to go into raptures over the discovery, they do confirm the finding of gold in an unprospected area, and consider that this should warrant prospecting.

Mexican Mining Law.—The *Engineering and Mining Journal* for October 23 publishes the alterations to the mining law of Mexico promulgated by the Carranza government in March and August of this year. We quote these alterations herewith, and refer to the subject in our editorial columns.

Mining Law of March, 1915; Modification and additions to the law: Articles 2, 5, 9 and 10 of the law of 1905 regulating the stamp tax and the tax on mining franchises were modified and added to in March, as follows:

Art. 2. There are subject to the internal stamp tax, without any other exceptions than those expressly fixed in this law, the metals which are produced in this Republic or which come from a foreign country. Said tax will be in future as follows: (*a*) On metals which are exported in the shape of ore or mineral or earth, cyanide or sulphide, furnace residue or in any other form and which are combined or mixed with substances which properly speaking are not metal, as follows: Gold at the rate of $110 per kilogramme. Silver at the rate of $2·60 per kilogramme. Copper at the rate of $0·035 per kilogramme. Lead at the rate of $0·06 per each ten kilogrammes. Zinc at the rate of $0·05 per each ten kilogrammes. (*b*) For the metals which are worked in the country, so that they do not remain mixed or alloyed except with other metals, and whatever be the assay of the product, there will be a reduction of 20% from the taxes fixed in the foregoing clause.

Art. 5. There is no tax on . . . etc. (*c*) The taxes on copper will not be levied when the ore contains the metal mentioned in less amount than 10%, nor on lead when the ore contains a smaller amount than 10%, nor on zinc when the ore contains a smaller proportion than 15%.

Art. 9. The tax of special stamps which, according to the laws now in force, have to be adhered to the titles of ownership of the mines, will be $10 for each unit of mining field (pertenencia) covered by these titles, whatever be the mineral substance which it is intended to produce.

Art. 10. The annual tax on mine ownership will be as follows: (*a*) The rate will be $12 yearly per unit of mining field (pertenencia) or $4 for every one-third of a year, whatever be the material being mined. (*b*) If the number of pertenencias of a mining property, or of diverse properties belonging to the same owner and located in the same mining district, exceeds ten pertenencias, the tax will be at the rate of $12 for the first ten pertenencias, and for the excess up to 20 at the rate of $15. For the excess from 20 up to 50 the rate will be $18, and from 51 up the rate will be $24.

To the mining fields that have payments of taxes pending and have not yet been declared void, a time will be conceded up to June 30, 1915, to pay their debts in gold, in accord with the foregoing rates of this decree.

All amounts which the Public Treasury has to receive in accord with the present decree and with the law of March, 1915, shall be paid in national gold money.

Changes in the Tax on Mining Property, Decree of August 31, 1915: Art. 1. For the periods of time hereafter mentioned, the accounts described in Art. 10 of the law of March 1915, which modifies Art. 1 of the previous decree, regarding mining taxes, are reformed as follows: *(a)* The amount will be $6 yearly for each mining pertenencia, whatever be the number of pertenencias, during the four months covered by the months from July to November of the present year. *(b)* The amount will be $8 yearly for each mining pertenencia whatever be the number of the pertenencias, during the four months from November of this year to February 1916. *(c)* From March 1, 1916, the amounts will be those established by the decree of March, 1915.

Art. 2. For the mining fields (pertenencias) for which payment of taxes prior to last July is pending, it is conceded that they pay $6 yearly, for each of the first 25 pertenencias and for the excess, $3.

Art. 3. To all the owners of mining property who have paid for the four months which commenced with last July, the excess will be returned, deducting what they have to pay according to this present decree.

Art. 4. A period of time is allowed until September 30, 1915, for payment, without extra charge, of the amounts fixed by the present decree.

Art. 5. The payments referred to in the present decree have to be made in national gold or its equivalent in silver, in accord with the decree of May 8, of the present year.

The dollar used in the above decrees is presumably the Mexican dollar or peso.

TECHNICAL JOURNALS FOR THE MONTH

[*In this department will be listed each month the leading articles dealing with metal mining and non-ferrous metallurgy that appear in the principal technical journals, though no attempt will be made to mention every item in every publication, and titles are necessarily shortened. Articles of purely local interest are omitted. The purpose is to record the more important and interesting current papers. Those which have especial bearing upon technological matters are given further notice in the Précis, and are indicated by an asterisk *. Copies of any of those listed can be obtained through The Technical Bookshop, Salisbury House, London, E.C., the book department of The Mining Magazine*].

BRITISH.

Colliery Guardian.—*October 16:* Editorial on Dr. Collis' lectures on Stone Dust and Mine Hygiene. *October 29:* Extinguishing gob-fire at Seaton Delaval.

Engineering.—*October 15, 22 and 29:* Hydro-electric Station to Supply Power to Iron Mines and Mine Railways at Kiruna and Gellivara, Swedish Lapland. *October 22:* Cooke's Direct-reading Tacheometer.

Iron and Coal Trades Review.—*October 15:* Indian Manganese Ore Industry. *October 22:* Germany's Supplies of Iron and Manganese Ores.

Manchester Geological and Mining Society. — *October meeting:* Continued discussion on Stratigraphy of Kent Coalfield, by E. A. Newell Arber and E. O. Forster Brown.

National Association of Colliery Managers.—North of England Branch, *October meeting:* Undersetting a Walling Crib, Jackson Swindle.

North of England Institute of Mining and Mechanical Engineers.—*October meeting:* J. B. Simpson presented original specimens of early forms of safety lamps and gave an outline of their history. T. Y. Greener, presidential address on Historical Account of Development of By-product Coke Ovens.

North Staffordshire Institute of Mining & Mechanical Engineers.—*October meeting:* Organization of the British Mining Industry especially with regard to supply of capital, T. Campbell Futers.

COLONIAL.

Canadian Mining Institute.—*Mon. Bull., October:* Cross-cut Adit Driven by the Portland Canal Tunnels, Ltd., W. J. Elmendorf; Mine Rescue and First Aid Work in Alberta, Duncan McDonald; Accident Prevention at Ontario Mines, T. F. Sutherland.

Canadian Mining Journal.—*October 1:* Kowkash Gold Area*, P. E. Hopkins; Kowkash District, Ontario*, Charles Spearman; Structural Features of the Porcupine Ore Deposits*, A. R. Whitman; Determination of Cobalt and Nickel in Cobalt Minerals, C. A. Knittel.

Mining and Engineering Review (Melbourne).—*September:* Draining and Conveying Waste Products from Flotation Plants*, W. Shellshear; Treatment and Marketing of Ores and Metals in Australia, 'Occasional Contributor.'

Queensland Government Mining Journal.—*September:* Annan River Tinfield, E. C. Saint-Smith; Mount Caslon Goldfield, and Proposed State Battery, W. E. Cameron.

South African Institution of Engineers.—*Journal for September:* Recovery of Bantjes Central Shaft*, P. Cazalet and W. W. Lawrie.

South African Mining Journal.—*September 11 and 18:* Oil Prospects in Portuguese East Africa*, J. E. Mills Davies. *September 11, 18, 25:* Mining Accidents of Various Types, C. E. Hutton.

FOREIGN.

American Institute of Mining Engineers.—*Bull., October:* Recent Advances in the Chemistry of the Cyanogen Compounds, J. E. Clennell; Control of Chill in Cast Iron, G. M. Thrasher; Newnam Hearth*, W. E. Newnam; Geology of the Ore Deposits of the Tintic District, G. W. Crane; Iron Deposits of Daiquiri, Cuba, W. Lindgren and C. P. Ross.

Colliery Engineer. — *October:* Welfare Work of the Frick Coke Co.

Columbia School of Mines Quarterly.—*April:* Basic Principles of Mining Cost, James R. Finlay; Tables for Determination of Gems and Precious Stones Without Injury to the Specimen, A. J. Moses; Design of Surface Combustion Apparatus, C. E. Lucke.

Economic Geology.—*July-August:* Oriskany Iron Ores of Virginia, and Ancient Sedimentary Iron Ores of British India, C. M. Weld; Oil Pools of Southern Oklahoma and Northern Texas, James H. Gardner; Topographic Features of Siberia, C. W. Purington; Origin and Occurrence of Certain Crystallographic Intergrowths, Julius Segall. *September-October:* Sulphides of Copper, E. Posnjak, E. T. Allen, and H. E. Merwin; Mineral Occurrences in the Worthington mine, Sudbury, T. R. Walker; Origin of the Sulphur Deposits of Sicily, W. F. Hunt.

Engineering and Mining Journal.—*September 25:* Stoping Methods at Fairbanks, H. I. Ellis; Explosives Used in War and Metal Mining, P. E. Barbour; Tin Ore Dressing at Llallagua—II. [concluded Oct. 3], D. Copeland and S. E. Hollister; Refining Cyanide Precipitates, H. T. Durant. *October 2:* Roosevelt Drainage Tunnel at Cripple Creek, T. H. Sheldon; Some Points in the Economics of Zinc Metallurgy*, W. R. Ingalls. *October 9:* Placers of Antioquia, Colombia, R. W. Perry; Coal Tar in Flotation, W. A. Mueller; First Aid at Ray, J. T. More; Arizona Copper Miners' Strike. *October 16:* Calamine Mines of Sardinia, C. W. Wright; Simple Cyanide-plant Design, S. A. Worcester; Wright Concentrating Table, C. W. Wright. *October 23:* Barrow Transport for Ore in Flat Stopes on the Rand, E. M. Weston; European Potash Deposits studied from the point of view of economic geology, E. Mackay Heriot [concluded October 30]; Mineral Resources of Newfoundland, P. B. McDonald. *October 30:* Winter Mining at Fairbanks, H. J. Ellis; Minerals of Asiatic Turkey; How to Choose Rock-Drills, J. R. McFarland.

Iron Age.—*October 7:* Reports of the Foundrymen's Atlantic City Convention, and of the meeting of the American Institute of Metals, with numerous notes on alloys and uses of various metals.

Journal of Geology.—*September-October:* Slide Rule in Computation of Rock Analyses, J. H. Hance.

Mexican Mining Journal.—*May:* La Lucha Cyanide Mill, T. E. Pratt*; The Holt-Dern Process, Clarence L. Larson; Early Mining History of Pachuca, M. B. Spaulding. *June:* Convenient Alkalinity Table, P. W. Avery; Keeping Records of Mine Sampling, A. Livingstone Oke. *July:* An Alternating Current Rectifier for Metallurgical Laboratories, P. W. Avery and A. O. Ullva.

Mining and Engineering World.—*September 18:* Rochester District, C. R. Bunker; Unnecessary Waste of Metals in Mining, S. E. Bretherton; Exploration and Drilling on the Cuyuna Range, P. W. Donovan; Lead Smelter Construction during 1915; Handling Heavy Material with Cableways, C. A. Tupper. *September 25:* Geliens Process of Treating Refractory Ores, G. A. Geliens; Gunite in Underground Mine Work, Stephen Royce; Professional Ideals and Economies, W. W. Rush; Grades and Kinds of Oil Used for Flotation; Factors Affecting Choice of Mine Cars, Gerald F. G. Sherman. *October 2:* Bisbee District, C. A. Tupper; Sheet Ground Mining in the Joplin District*, Edwin Higgins; Metallurgical Exhibit at the Panama-Pacific, A. E. Wells and G. H Clevenger. *October 9:* Water Power Development in British Columbia, G. A. Ohren. *October 16:* Nevada-Douglas Process of Ore Leaching, A. J. Orem; Calculating flow of Air and Gas in Low-Pressure Line; Future of American Zinc Industry, Otto Ruhl.

Mining and Metallurgical Society of America.—*Bull., Sept. 30:* Discussion by members of the New York section of the preliminary report committee on Standardization, see body of *The Mining Magazine.*

Mining and Scientific Press.—*September 18:* Why is Flotation? C. T. Durell; Ore Dressing on the Mother Lode, E. S. Pettis; Geology as an Aid to Tropical Engineering, W. D. Smith; Mining in Utah, L. O. Howard; What is Flotation?—II., T. A. Rickard; Manhattan Nevada, Percival Nash; Round Lake Mine, C. P. Bowie; First Aid and Mine Rescue Contests at the Exposition. *October 9:* Hoisting Works at Park City—I., L. O. Howard; Valuation of Metal Mines, T. A. Rickard; Mining in Colorado, G. J. Bancroft; Igneous Intrusions, T. A. Rickard; What Constitutes a Mining College, P. B. McDonald. *October 16:* Air-Froth Flotation, a legal version of the technology of the process; Coarse-Crushing Plant of 1000 tons capacity, G. O. Bradley. *October 23:* Why do Minerals Float? O. C. Ralston; Hoisting Works at Park City, L. O. Howard; Geology of Iron Mountain, O. H. Hershey.

Revista Minera.—*October 16:* South American Minerals and Industrial Union of Spain with Latin America, by A. E. L.; Copper Mines of Montana.

Teniente Topics.—*July:* Mines of the Braden Copper Co., H. R. Graham; Horwood Process at the Zinc Corporation, Allan D. Ryan.

Western Engineering.—*October:* Electro-Chemical and Electro-Metallurgical Possibilities of the Pacific Coast*, J. W. Beckman; Valuation of Ore Lands and Properties, M. E. Lombard (Details of method discussed editorially in *The Mining Magazine* for May.)

NEW BOOKS

Theory and Practice of Ore-Dressing. By Edward S. Wiard. Cloth, octavo, 430 pages, illustrated. New York: McGraw-Hill Book Co. Price 17s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

The author of this book has had his own troubles in concentration problems, and has taken a great deal of pains to give the metallurgical engineer and millman the benefit of his valuable experience. He has covered in a single volume the whole subject of ore-dressing as applied to metalliferous mines in Western America, where the treatment of large low-grade deposits has necessitated a careful selection of concentrating machinery, and the best talent that could be obtained. He begins with the preliminary conditions relating to the installation of ore-dressing plants, describing the various classes of concentratable ores. This will allow an engineer to classify his ore, as to whether it should be hand-sorted before crushing or after; whether it should be rough concentrated by bull jigs; whether it should be stage-crushed and concentrated, or all crushed down for concentration in the first operation; and the most important point, whether it should be concentrated at all by wet concentration.

The chapter relating to testing of concentrating ores is good. It explains methods of determining whether the ore can be concentrated, and if so how to obtain the best results from the ore, giving tables and diagrams showing how far concentration can be carried before the cost exceeds the value in extra recovery. Much interesting matter is given to indicate the methods for getting information when designing a flow-sheet for a concentrating plant. The section devoted to the location of a concentration plant gives many interesting figures worth considering by the engineer in laying-out a plant, and calls attention to important factors to be taken into consideration which are often overlooked. The description of the crushing plant, separation or hand-sorting plant, general dissertation on crushing, heavy crushing machinery, rolls, and medium crushers are invaluable to the designer. The question of the means of raising ore or ore and water is a point in connection with the mill to which many engineers and designers pay little attention, but it is a most important factor in mill designing. The author makes clear the value of good elevators, and how to design them. The descriptions of concentration of sand, settling and collecting of slime, and the final concentration of slime are well written. The many working drawings and illustrations of the various types of machines are excellent, being very clear and distinct.

The book should appeal to the practical millman as well as the designing engineer and metallurgist. It will make an excellent text-book for students.

ALFRED TELLAM.

Chlorine and Chlorine Products. By Geoffrey Martin. With a Chapter on Recent Oxidizing Agents, by G. W. Clough. Cloth, octavo, 108 pages, illustrated. London: Crosby Lockwood & Son. Price 7s. 6d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

This volume forms one of the new series of works on industrial chemistry recently placed on the market by Crosby Lockwood & Son, to which attention has been called in these columns on several occasions lately. The first chapter describes the older processes for producing chlorine from the hydrochloric acid evolved in the treatment of salt with sulphuric acid in the manufacture of alkali. The second deals with the modern electrolytic processes for the decomposition of brine. The third describes the method of preparing liquid chlorine, which has to a large extent displaced bleaching powder and is of interest at present owing to its employment in warfare. The fourth chapter deals with chlorates and perchlorates, and the fifth with bleaching powder and hypochlorites, the latter being largely used nowadays as bleaching agents instead of chlorine released from bleaching powder. Subsequent chapters are devoted to hydrochloric acid, bromine, iodine, and hydrofluoric acid. The section by Mr. Clough relating to recent oxidizing agents describes the peroxides and peracids.

Mineral Resources of Minas Geraes, Brazil. By Albert F. Calvert. Cloth, octavo, 100 pages of text, with 117 plates of photographs and maps. London: E. & F. N. Spon. Price 6s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

As we have remarked on a previous occasion, Mr. Calvert has a remarkable faculty of collecting and collating information on widely divergent subjects and of presenting it in eminently readable form. In this volume he describes the mineral resources of a State in Brazil famous for its gold, diamond, iron, and manganese deposits, and he usually quotes the most reliable authorities. He is naturally keen on seeing a mining boom for Brazil, and wonders why one does not arrive. The photographs included in the book are extremely interesting.

RECENT PUBLICATIONS.

Mining World Index of Current Literature.—This is the seventh half-yearly volume of the index of mining literature prepared by the *Mining and Engineering World*. We have on several previous occasions acknowledged the good work done in this direction by George E. Sisley, the associate editor of our Chicago contemporary.

Sludge Abatement.—The Report of the Sludge Abatement Board of Victoria for the year 1914 gives an account of the disposal of the tailing and the water at the various alluvial workings. The series of photographs give a good idea of the re-soiling and re-levelling of the flats through which the dredges pass.

Mineral Production of California for 1914.—The detailed report of the mineral yield of California for 1914 is just to hand. The particulars of the production of gold, quicksilver, and petroleum are of special interest, as the State is a most important producer under these headings. The report also contains an outline of Californian and Federal mining laws.

Coals of South Wales with Special Reference to the Origin and Distribution of Anthracite.—A publication of the English Geological Survey, by Aubrey Strahan, W. Pollard, and E. G. Radley. It is not generally known that in the western part of the South Wales coalfield anthracite is mined, of a nature identical with that found in Pennsylvania.

Platinum and Allied Metals in 1914.—A report by James M. Hill, for the United States Geological Survey. It gives details of platinum production in the United States, and estimates of the world's output by countries, with records of prices and imports. The uses of the metal are described, and recent papers on the determination of platinum are reprinted. Information is included relating to allied metals, particularly palladium, iridium, and iridosmine.

COMPANY REPORTS

Spassky Copper Mine.—This company was formed in 1904 to acquire from local owners the Yuspenssky copper mine, the Spassky mine and smelting works, and the Karagandy coal mine, in the Akmolinsk district of southwest Siberia. In 1911 a controlling interest in the Atbasar Copper Fields company was purchased, and in 1913 the rest of the share capital of the Atbasar was acquired in exchange for Spassky shares. E. T. McCarthy is consulting engineer, and H. C. Woolmer is general manager. The report for the year 1914 shows that the high-grade ore on the 350-ft. and 420-ft. levels at the Yuspenssky mine is exhausted. Thus the tonnage of first-class ore raised, averaging 20% copper or over, was only 20,697 tons, about 13,000 less than the previous year. At the smelter 30,473 tons of ore was treated, yielding 4683 tons of copper, as compared with 5007 tons during 1913. The development during the year has shown that the rich ore-shoot becomes shorter in depth and that it is much smaller on the 630-ft. level than the 560-ft. level. The reserve of rich ore in the Yuspenssky is estimated at 6100 tons, and that still available on the Spassky and Yuspenssky dumps at 21,083 tons. The reserve of lower-grade ore at Yuspenssky is estimated at 346,917 tons, averaging 7% copper. A concentrator is being erected to deal with this ore, and corresponding modifications have been made in the smelting plant, on the advice of Walter G. Perkins. At the Karagandy coal mine, 80,901 tons was raised, an increase of 9422 tons over the figures for 1913. At the Atbasar property 3072 ft. of development work was done during the year, and the ore disclosed averaged 12·6% over 2·3 ft. The developed ore reserve is estimated at 150,400 tons averaging 13·1%. The Spassky company sold 4683 tons of copper during the year for £444,563, the price obtained in Russia being approximately 30% higher than in London. The net profit was £115,502, out of which the directors have declared a dividend of 10%, absorbing £97,894. The accounts have been prepared at the normal rate of exchange between the rouble and the pound, but as the rouble is now greatly depreciated, it is impossible to transmit profits to London. Accordingly the distribution of the dividend is postponed at the discretion of the directors.

North Anantapur Gold Mines.—This company was formed by John Taylor & Sons in 1908 as a subsidiary of the Anantapur Gold Field company, the parent company that had explored and developed old workings in Madras Presidency, India. In 1911 additional capital was subscribed by the issue of £25,000 preference shares of £1 each. The issued ordinary share capital is £76,253 in £1 shares, of which £40,000 was allotted to the vendor company. Milling was commenced in 1910, and additional stamps, a tube-mill, and cyanide plant have since been erected. The report for the year ended June 30 last shows that an average of 28 stamps out of 30 ran on an average 16 days per month. During this time 22,860 tons of ore was milled, for a yield of 14,855 oz. worth £62,945. During the previous year an average of 25 stamps ran 263 days, and treated 25,450 tons, for a yield of 11,067 oz. gold worth £46,888. The yield per ton was 13 dwt., as compared with 9·7 dwt. the previous year. The reason for the smaller tonnage and higher yield per ton is found in the fact that shrinkage stoping has been adopted for the wider and lower-grade parts of the lode, and that as this ore cannot be drawn immediately on stoping, the narrower and richer parts of the lode had to be stoped in order to keep the mill going, and so maintain the estimated output of gold. Of the yield of gold 12,905 oz. came from the plates, and 1950 oz. from the cyanide plant. The working profit for the year was £24,642, from which £4082 was written off for depreciation of plant, and £8500 off suspense account and £500 off insurance and contingency account. The preference shares received 25% dividend and the ordinary shares 5% dividend. The ore reserve is estimated at 54,000 tons as compared with 52,000 tons the year before. On the 750-ft. and 850-ft. levels, the latest news is encouraging. On the 750-ft. level the ore-shoot is found to pitch farther to the north, and the workings are approaching the dike. It is expected that on the 850-ft. level the shoot will meet the dike, and then the interesting problem will be whether the shoot will be found on the other side.

Cornwall Tailings.—This company was formed in 1910 to buy the old tailing heaps belonging to the Carn Brea and Tincroft company at Camborne. The control is with the Lempriere-Lionel Robinson group, Arthur Richards is managing director, and Ross K. Macartney is manager. The tailing is re-ground and re-treated on tables and buddles. The report for the year ended February 28 last shows that 144,460 tons was treated, for a yield of 432 tons of tin concentrate, the recovery being 27·3% of the content indicated by chemical assay. The concentrate sold for £31,632. In the previous year 369 tons of concentrate was obtained from 113,116 tons of tailing, and was sold for £35,659. The treatment expenses were £21,650, or 3s. 2d. per ton. Administration expenses, taxes, and allowance for depreciation reduced the net profit to £1135, which was carried forward. The heaps are estimated to contain 650,000 tons, but owing to the low price of tin it will be necessary to select the best. Thus the eventual remainder will be of much lower content than the average at present. Mr. Richards states that smelters are nowadays taking concentrate of lower grade than formerly, and a proportion of the company's output is being delivered in this form. Experiments are still being made with various processes invented for the purpose of chemically extracting the unrecovered tin. A volatilization process was tested on a small working scale with encouraging results, but its development as a commercial method would have required a larger expenditure than is warranted at present.

Central American Mines.—This company was formed in November 1913, as a reconstruction of the Oroya Leonesa, which was originally formed in 1910 to acquire, from the Oroya Brownhill company, the Leonesa gold-mining properties near Matagalpa, Nicaragua. On the latter date the Lake View Consols and allied companies operating at Kalgoorlie had applied funds in other parts of the world, and on the exhaustion of their principal mines a rearrangement of holdings was made so as to separate the mining and the financial ventures. The Leonesa mine started operations in 1912 with 20 stamps. Revolutions and shortage of labour prevented the mining and milling operations from being conducted on the scale expected, and further capital was required. Hence the reconstruction in 1913. The Lake View and Oroya Exploration guaranteed the subscription to the shares in the reconstructed company, and purchased all the shares not taken up. The Lake View is now the largest shareholder, and is also the owner of the £35,000 debentures. The report now issued covers the period from the registration to the end of 1914, and is accompanied by a report by J. A. Agnew, who has recently visited the property. Owing to shortage of power, and difficulties in connection with extraction, the mill ran only 55% of the time. The amount of ore treated was 31.556 tons, and the yield of gold was worth £38,279. The accounts for the year show a loss of £15,654. Since the end of the year, however, extraction has been improved, and the working cost greatly reduced, so that the debt has been entirely wiped off and the debenture interest paid up to June 30. The ore reserve was estimated on December 31 at 83,606 tons, averaging 38s. 6d. per ton, and development since then has fully maintained these figures. Great difficulty is experienced in securing suitable labour for sinking and driving. The metallurgical troubles were caused by the presence of a large proportion of finest slime that would not settle well. Since the installation of mechanical settlers the results have greatly improved.

Tomboy Gold Mines.—This company was floated in 1899 by the Exploration Company to purchase the mine of that name in the Rocky Mountains, above Telluride, Colorado. In 1901 the ore showed signs of approaching exhaustion, so the Argentine property near-by was acquired. In 1911 the Argentine began to give poor results, and the Montana group of claims on the opposite side of the basin was purchased from the Revenue Tunnel Co. The gold occurs both free and in the sulphides of base metals, and the ore is concentrated after amalgamation, the final quartz tailing being cyanided. Modifications in the concentration plant have recently been introduced owing partly to the Montana ore being of a different nature from that at the Argentine. The cyanide plant started work in December last. The report for the year ended June 30 shows that 145,857 tons of ore was sent to the mill, most of it from the Montana group. The yield by amalgamation was $414,114, the concentrate sold for $537,494, and the cyanide bullion for $75,915, a total yield of $1,027,524. The yield per ton was $7·05, and the working cost at the mine $4·49. The accounts show a total income of £215,705, and a profit of £79,705. Out of this profit, £8000 has been paid or reserved for income tax, £31,486 has been written off for the cost of the new plant and £18,000 for other items of machinery, and £2732 has been written off the cost of the company's holding in the Tomboy Tramway & Tunnel Co. Adding £47,792 brought forward from the previous year, the available balance for distribution was £67,278, out of which £46,500 has been paid as dividend, being at the rate of 15%. As already mentioned, the cyanide plant started in December. At first the extraction was not up to expectations. On examination it was found that an improvement was obtained by using a more dilute pulp in the agitators. As regards development at the mines, no ore of importance was found in the Argentine group, where 185,000 tons remains to be treated. At the Montana group, the results have been encouraging at many points, and the reserve has been increased, standing now at 350,000 tons. D. A. Herron is manager, Philip L. Foster is consulting engineer, W. K. Betty is consulting metallurgist, and Gelasio Caetani designed the improved arrangement of the concentration plant. At the meeting of shareholders, the chairman announced that a purchase had been effected of the Sydney-White Cloud group of claims which cover an extension of the Montana property.

Jumbo Gold.—This company belongs to the Lewis and Marks group, and was formed in 1906 to acquire a gold mine in the Mazoe valley, Rhodesia, 30 miles north of Salisbury. From May 1906 to the end of August 1915, 141,322 fine ounces of gold has been extracted from 302,127 tons of ore, but no dividend has ever been paid. For the last three years there has been practically no reserve of ore, and the mill has been worked at a capacity depending on such ore as has been rendered available by current exploration. In August 1914, the number of stamps employed was reduced from 30 to 25, and in September to 20. The report for the year ended June 30 last shows that 26,150 tons of ore was milled, and gold worth £33,116 extracted. The working cost was £31,398. After allowing £9004 for depreciation and paying administration expenses, the net loss for the year was £7744. Cyril E. Parsons, the consulting engineer, reports that it is still difficult to find ore. Work is to be continued in the hope of making new discoveries. The ore now being milled is of much lower grade than in the earlier years, when 50s. was the average.

Consolidated Main Reef.—This company was formed in 1896 to acquire gold-mining properties in the middle west Rand, owned by the Main Reef and Consolidated Angle-Tharsis, two companies that were formed in 1888 and 1893 respectively. The control is with the Neumann group. David Wilkinson is consulting engineer, and J. E. Healey is manager. Milling commenced in 1888, but was subsequently suspended on many occasions. The first dividend was for the year ended June 30, 1907, when the rate was 5%. The rate has gradually increased until 12½% was distributed for the year ended June 30 last. The report for the past year shows that the shortage of labour that hindered operations during the previous year had been overcome, and that in consequence the tonnage was increased. The amount of ore raised was 337,805 tons, and after the rejection of 12·7% waste, 294,866 tons was sent to the mill. The yield of gold was worth £442,649, or 30s. per ton milled, and the working cost was £304,384 or 20s. 7d. per ton. Out of the profit £33,497 was spent on capital account, chiefly on shaft-sinking and compressor plant. The shareholders received £115,545, or 12½%. As compared with the previous year the tonnage milled was 53,759 tons greater, the total yield £63,098 more, the yield per ton 1s. 5d. less, and the working cost per ton 1s. 2d. less. Development was vigorously conducted, and no less than 382,620 tons of ore averaging 7·85 dwt. over 48 in. was disclosed. The ore reserve is estimated at 855,600 tons averaging 7·53 dwt. over 48 in., an increase of 162,140 tons in the amount, and of 0·19 dwt. in the assay-value as compared with the previous year.

Main Reef West.—This company was formed in 1899 to acquire gold-mining property in the middle west Rand, on the dip of the Aurora and New Unified, and to the west of the deep-level section of the Consolidated Main Reef. The control and management are in the same hands as the Consolidated Main Reef, details of which are given in the preceding paragraph. Milling commenced in February 1909, and the plant contains 120 stamps and 3 tube-mills. The capital is £491,188 in shares of £1 each, of which 391,188 were issued as fully paid to the vendors, while 100,000 were subscribed at £2 each, on the formation of the company. Debentures to the extent of £300,000 were issued in 1909. The dividends have been 25% for the year ending June 30, 1910, 22½%, 15%, and 5% for the next three years, and nothing since. As announced in our September issue, additional funds are required for developing the mine at depth, and the debenture-holders have agreed to a temporary postponement of the yearly redemption of debentures. The report for the year ended June 30 last shows that the labour supply has increased again, so that the tonnage treated was greater than during the preceding year. The amount of ore raised was 300,477 tons, and after the rejection of 10% waste, 269,770 tons was sent to the mill, at which 100 stamps were at work. The yield of gold was worth £318,714, or 23s. 7d. per ton milled, and the working cost was £267,838, or 19s. 10d. per ton. Out of the profit, £7699 was applied to capital expenditure, chiefly on plant, £14,920 was paid as debenture interest, and £25,000 allocated to debenture redemption. As compared with the previous year, the tonnage milled was 56,548 tons greater, the total yield £15,604 greater, the yield per ton 4s. 9d. less, and the cost per ton 3s. 3d. less. Development during the year disclosed 115,710 tons, averaging 5·75 dwt. over 48 in. The reserve is estimated at 416,280 tons, averaging 5·87 dwt. over 51 in., being a decrease in amount of 110,160 tons, and 0·13 dwt. in assay-value as compared with the year before. In order to develop the lower levels, it is intended to sink two subsidiary inclines from the 15th level, on the east and west sections respectively.

Swaziland Tin.—This company was formed in 1905 under Transvaal laws to acquire tin-gravel properties at Embabane, Swaziland. The company is a subsidiary of the Transvaal Consolidated Land & Exploration Co., and is under the control of the Central Mining—Rand Mines group. J. Jervis Garrard is the consulting engineer, and T. Kelly is manager. The capital is £82,000, and dividends have been paid continuously. The report for the year ended June 30 shows that the amount of gravel treated continues to increase, and that the working cost per ton has been substantially reduced. The gravel treated was 961,550 cu. yd., as compared with 722,014 cu. yd. the year before, and the tin concentrate produced was 431 tons as compared with 379 tons. The revenue from the sale of concentrate was £42,937 as compared with £39,725. The yield per yard was 1·004 lb. of concentrate as compared with 1·178 lb., and the metallic content of the concentrate was 71·25%, as compared with 71·9%. The working profit was £14,457, out of which £6150 has been distributed as dividend, being at the rate of 7½%. Mr. Garrard reports that the reserve of proved gravel is 4,420,000 cu. yd., averaging 1 lb of metallic tin per yard, and that an additional 5,000,000 cu. yd. is known to be tin-bearing, though the exact content has not yet been proved. Large tracts of gravel on the concession will be examined and tested later.

North Broken Hill.—On the outbreak of war the mine and mill were closed for some weeks, but operations were subsequently recommenced, on a scale governed by the capacity of the Port Pirie smelter, which undertook the smelting of local lead concentrate on a co-operative system as already detailed in our pages. The report for the half-year ended June 30 shows that the time worked was 78% of the normal, the works being closed for 5 weeks out of 26. The amount of ore treated at the lead concentrating plant was 123,455 tons averaging 15·8% lead, 12·9% zinc, and 7·4 oz. silver per ton. During the corresponding period of 1914 the ore treated was 156,020 tons. The yield of concentrate was 24,430 tons averaging 61·9% lead, 8·8% zinc, and 21·1 oz. silver. The zinc tailing produced was 56,202 tons averaging 16·2% zinc, 3·2% lead, and 3·3 oz. silver, and the slime 15,410 tons averaging 12% lead, 15% zinc, and 9·3 oz. silver. The zinc tailing was delivered to the Amalgamated Zinc (De Bavay's) company, and the slime was stored. The development underground has been chiefly centred on the sinking of winzes and providing of ladderways with the view of improving ventilation and affording additional means of exit from the lower levels. The work on the lowest level, 1400 ft., has disclosed ore of excellent grade, averaging 16% lead. The accounts show credits of £210,304, and a net profit of £55,210, out of which £30,000 has been paid as dividend, being 1s. per £1 share for the half-year. As recorded in our pages already, the Proprietary sold the Port Pirie smelter in June to a subsidiary, in which other Broken Hill companies participated. The North company subscribed £200,000 in the smelter company, and raised the money by issuing debentures. The whole of the Port Pirie output of soft lead, antimonial lead, and spelter was offered to the Imperial authorities, but at the date of the report, September 1, advantage had not been taken of this offer.

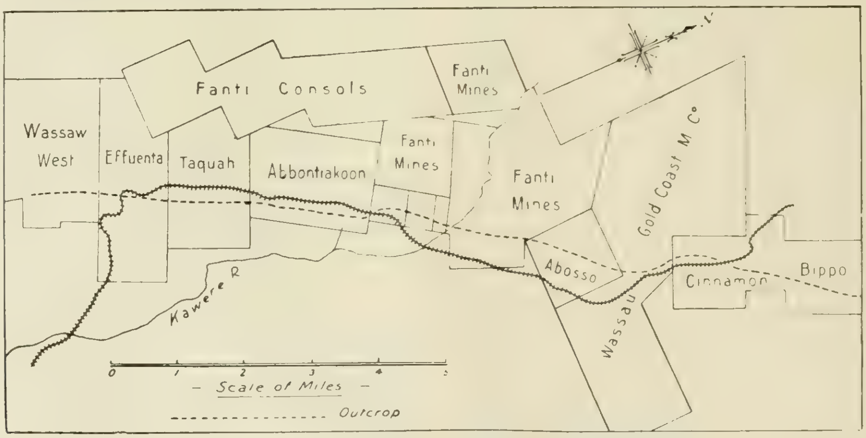
Broken Hill South Silver.—This company operated under much the same conditions as the North, details of which appear in the preceding paragraph, and its participation in the new smelting company is the same. During the half-year ended June 30, the mine and mill were idle for a total of seven weeks. The amount of ore raised was 131,059 tons, averaging 14·9% lead, 14·7% zinc, and 7·5% silver per ton. At the lead mill 24,961 tons of lead concentrate was extracted, averaging 61·2% lead, 9·7% zinc, and 22·2 oz. silver. In addition 80,880 tons of zinc tailing was produced averaging 17·2% zinc, 3% lead, and 3·5 oz. silver, together with 18,614 tons of slime, averaging 8·6% lead, 13·7% zinc, and 7·2 oz. silver. During the corresponding period a year ago, the ore mined and milled was 172,421 tons. The zinc tailing was delivered to the Amalgamated Zinc (De Bavay's) company. In order to meet the requirements of the smelter, silicious lead-mill slime is being delivered in a specified proportion to the lead concentrate. The dumps of accumulated tailing and slime contain 891,835 tons of old-mill tailing averaging 16·2% zinc, 5·6% lead, and 3·5 oz. silver. These are under contract of sale to the Zinc Corporation. Owing to the latter company having had no outlet for zinc concentrate, none of the dump material was delivered during the half-year. The other dumps contain 413,004 tons of slime averaging 11% lead, 14·1% zinc, and 6·1 oz. silver. The accounts show credits of £218,525 for lead concentrate and slime, and £68,221 for zinc tailing. The net profit was £123,772 and out of this £30,000 was distributed as dividend on a paid-up capital of £163,692.

Burma Corporation.—This company was formed in 1913 to acquire the share capital and the majority of the debentures of Burma Mines Limited, and to continue and expand the mining operations of that company. H. C. Hoover is chairman, R. Gilman Brown and Walter McDermott are on the board, and the technical committee is composed of Theodore J. Hoover, R. Gilman Brown, E. Heberlein, and A. F. Kuehn. The property has been described in some detail in our columns, notably in the issues of May and June 1914, and January 1915. The original company was formed in 1904 to acquire silver-lead mines and slag heaps at Lashio, in the Northern Shan States, Burma. The present work is the development of unusually rich and extensive lodes containing mixed lead-zinc sulphides. The report now published contains the accounts as at December 31, 1914, but the accompanying report of the technical committee brings the information down to August 31 last. In the balance sheet it is shown that 761,372 shares of £1 each had been issued. Since that date 152,377 shares have been issued, bringing the total to 913,749. There have also been created £65,000 6% debentures, of which £14,000 have been issued in exchange for debentures in Burma Mines Limited. The corporation now owns 99·8% of the shares and 77% of the debentures of Burma Mines

Limited. The technical committee reports that work is centred on the development of the Chinaman orebody. The orebody has been explored to a depth of 446 ft. below the Chinaman Tunnel level, and the internal shaft is now within 50 ft. of the level of the Tiger tunnel. The latter tunnel will be 6000 ft. long, and 2921 ft. has already been driven. It will serve as the main outlet for ore and will also drain the mine. In exploration underneath old workings, large stretches of high-grade silver-lead ore were disclosed, assaying 40 to 50% lead and 40 to 50 oz. silver per ton. Ore of this tenor removed in development, together with old slags, has been smelted. The ore reserve was estimated on August 31 at 2,000,000 tons averaging 27% lead, 22½% zinc, and 25 oz. silver; of this, 250,000 tons consists of high-grade ore averaging 45% lead, 21% zinc, and 44 oz. silver. An experimental concentrator has given sufficiently good results to justify its expansion to a capacity of 100 tons per day. The enlarged plant will be used for further tests, and will at the same time supply lead concentrate to the smelter. The results obtained show that lead and zinc concentrates can be produced suitable for direct metallurgical treatment. Thus the necessity for selling ore or rough concentrate will be obviated. During the first half of 1915, the output of refined lead was 457 tons per month. Arrangements are being made to treat more ore and less slag, and to produce 1500 tons of lead and 140,000 oz. silver per month.

Taquah Mining & Exploration.—This company was originally formed in 1888 as the Taquah & Abosso Gold Mining Co. to acquire gold mining properties in the Tarkwa district, West Africa. From 1892 to 1898 milling was conducted on a small scale. In 1901 the company was split, and the Abosso mine transferred to a subsidiary. The first dividend of the Taquah company was paid in 1909, and the next in 1914. Milling was suspended for a year from the middle of 1910. The control passed five years ago to the Oceana Consolidated, which provided additional working capital on loan. G. W. Campion is the manager. The report for the year ended June 30 shows that 69,509 tons of ore was milled, for a yield of 48,971 oz. gold worth £207,687, being an extraction of 14 dwt. or 59s. 9d. per ton. The working cost was £118,646, or 34s. 1d. per ton, showing a reduction of 4s. 11d. per ton during the year. The ore reserve has been fully maintained, and on June 30 was estimated at 196,803 tons averaging 60s. 9d. per ton. Developments on the 10th level indicate the existence of an additional lense of ore. The accounts show that £29,166 has been paid as the final extinguishing of the loan advanced by the Oceana Consolidated. The dividends absorbed £58,121, the distribution being at the rate of 15 per cent.

Abosso Gold.—In the preceding paragraph, note is made that this company was formed in 1901 as a subsidiary of the Taquah Gold Mining & Exploration Co. Dividends at the rate of 10% on £400,000 were paid in 1906-7-8, and 5% since, except in 1912 when nothing was paid. The report for the year ended June 30 shows that 43,006 oz. gold worth £182,152 was recovered from 107,240 tons of ore, the yield being 8 dwt. or 33s. 11d. per ton. In addition 33,851 tons of custom ore from the Cinnamon Bippo was treated. The working cost was £149,014 or 27s. 9d. per ton. After allowance for depreciation and other charges, the net profit was £23,920, out of which £20,000 was distributed as dividend, being at the rate of 5%. The ore reserve has been well maintained, and stood on June 30 at 270,700 tons averaging 33s. 3d. per ton.



GOLD MINES IN THE TARKWA DISTRICT, WEST AFRICA.

E. W. Spencer has been appointed manager in succession to Stuart Love, who has joined the army.

Glynn's Lydenburg.—This company was formed in 1895 to acquire a gold mine on the Sabie river, near Pilgrim's Rest, in the Lydenburg district of the Transvaal. The control is with the Central Mining group, and George C. Damant is manager. Milling started in 1897 with 10 stamps, and the plant has been increased by the addition of another 10 stamps in 1905 and a tube-mill in 1910. Dividends have been paid continuously, at an average rate of 20% on a capital of £170,000. During the last two or three years, the results of development have caused some anxiety, but production has been maintained. The report for the year ended July 31 shows that 47,809 tons of ore was sent to the mill, averaging 8·8 dwt. per ton, and that the yield of gold by amalgamation was 6775 oz., and by cyanide 13,165 oz., a total of 19,940 oz., worth £83,271, being an extraction of 8·3 dwt. or 34s. 10d. per ton. The working cost was £52,548, or 21s. 11d. per ton. The dividend absorbed £34,000, being at the rate of 20%. The reserve is estimated at 65,000 tons, averaging 8·4 dwt. The developments at Mill Hill have been satisfactory, but at the Werf Mynpacht, which is considered to afford the best chances for the future, development was restricted owing to floods.

The Mining Magazine

Scientia non habet inimicum nisi ignorantem.

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QUOTATIONS

of leading mining shares on the London Market.
Shares are £1 par value except where otherwise noted.
Quotations are given in shillings.

GOLD, SILVER, DIAMONDS:	July 1 1914	Nov. 2 1915	Dec. 1 1915
Rand:			
Bantjes	14	6	5
Brakpan	51	65	66
Central Mining (£12)	160	125	127
Cinderella	6	4	5
City & Suburban (£4)	52	42	45
City Deep	66	66	69
Consolidated Gold Fields	43	25	29
Consolidated Langlaagte	35	37	38
Consolidated Main Reef	18	19	20
Crown Mines (10s.)	120	72	70
D. Roodepoort Deep	17	15	15
East Rand Proprietary	33	22	23
Ferreira Deep	47	42	40
Geduld	23	32	35
Geldenhuis Deep	26	20	20
Gov't Gold Mining Areas	23	26	28
Heriot	55	59	62
Jupiter	5	6	6
Kleinfontein	24	24	25
Knight Central	8	13	11
Knight's Deep	35	24	30
Langlaagte Estates	20	18	19
Luipaard's Vlei	10	7	8
Main Reef West	7	6	6
Meyer & Charlton	115	105	112
Modderfontein B	89	111	120
Modder Deep	58	102	114
Modderfontein, New (£4)	263	301	305
Nourse	27	20	19
Rand Mines (5s.)	120	82	85
Randfontein Central	17	11	12
Robinson (£5)	57	27	27
Robinson Deep	33	21	23
Rose Deep	43	32	32
Simmer & Jack	12	8	10
Simmer Deep	1	3	3
Springs	11	27	34
Van Ryn	67	52	54
Van Ryn Deep	47	54	58
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Village Main Reef	40	22	23
Witwatersrand (Knight's)	71	57	59
Witwatersrand Deep	48	29	30
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Chartered	17	9	11
Eileen Alannah	11	8	10
Eldorado	18	9	12
Enterprise	9	5	5
Falcon	14	8	9
Giant	14	9	7
Globe & Phœnix (5s.)	32	25	27
Lonely Reef	27	20	24
Shamva	46	36	40
Wanderer (5s.)	3	1	1
Willoughby's (10s.)	7	4	5
Others in South Africa:			
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Glynn's Lydenburg	11	9	9
Jagersfontein	78	62	64
Premier Diamond Defer'd (2s. 6d.)	152	85	97
Sheba (5s.)	4	3	3
Transvaal Gold Mining Estates	37	30	27
West Africa:			
Abbontiakoon (10s.)	8	7	7
Abosso	14	7	8
Ashanti (4s.)	16	17	18
Broomassie (10s.)	2	½	½
Prestea Block A	15	9	8
Taquah	15	14	15
West Australia:			
Associated Gold Mines	7	3	6
Associated Northern Blocks	7	3	3
Bullfinch	6	6	6
Golden Horse-Shoe (£5)	43	40	40
Great Boulder Proprietary (2s.)	14	15	16
Great Boulder Perseverance	2	1	1
Great Fingall	9	1	2
Ivanhoe (£5)	50	45	46
Kalgurli	36	15	16
Sons of Gwalia	23	14	17
Yuanmi	3	2	2

GOLD, SILVER, *cont.*	July 1 1914	Nov. 2 1915	Dec. 1 1915
Others in Australasia:			
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Consolidated Gold Fields of N.Z.	13	11	11
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Mount Morgan	52	40	40
Progress	10	5	5
Talisman	33	15	16
Waihi	42	35	36
Waihi Grand Junction	25	20	20
America:			
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Buena Tierra	15	14	14
Butters Salvador	20	15	15
Camp Bird	9	8	8
Canadian Mining	—	8	11
Casey Cobalt	13	5	7
El Oro	14	11	10
Esperanza	15	11	11
Kirkland Lake Proprietary	74	25	15
Mexico Mines of El Oro	97	85	85
Oroville Dredging	10	14	14
St. John del Rey	15	16	16
Santa Gertrudis	11	10	11
Tomboy	22	21	24
Tough-Oakes	28	7	13
Russia:			
Lena Goldfields	43	31	31
Orsk Priority	7	9	8
India:			
Champion Reef (2s. 6d.)	11	10	10
Mysore (10s.)	93	80	80
Nundydroog (10s.)	27	26	26
Ooregum (10s.)	23	23	24
COPPER:			
Anaconda (£10)	126	355*	371*
Cape Copper (£2)	60	50	50
Chillagoe (10s.)	1	¼	¼
Cordoba (5s.)	6	2	4
Great Cobar (£5)	3	3	3
Great Fitzroy (5s.)	½	¼	¼
Hampden Cloncurry	27	28	29
Kyshtim	55	38	38
Messina (5s.)	15	14	12
Mount Elliott (£5)	55	55	55
Mount Lyell	23	22	24
Rio Tinto (£5)	1355	1085	1120
Sissert	25	21	20
South American Copper (2s.)	22	12	11
Spassky	52	36	39
Tanalyk	78	35	35
Tanganyika	40	24	28
LEAD-ZINC:			
Broken Hill:			
Amalgamated Zinc	28	25	27
British Broken Hill	36	19	20
Broken Hill Proprietary (8s.)	36	44	47
Broken Hill Block 10 (£10)	32	16	16
Broken Hill North	52	37	43
Broken Hill South	175	124	142
Sulphide Corporation (15s.)	26	19	23
Zinc Corporation (10s.)	19	12	13
Asia:			
Burma Corporation	28	29	31
Irtysh Corporation	—	32	36
Russian Mining	31	14	15
Russo-Asiatic	151	79	90
TIN:			
Nigeria:			
Bisichi	8	4	6
Jos (5s.)	5	3	4
Kaduna (5s.)	15	15	15
Naraguta	17	10	12
N. Nigeria Bauchi (10s.)	3	1	2
Rayfield	5	2	4
Ropp (4s.)	100	14†	13†
Other Countries:			
Aramayo Francke	31	27	27
Briseis	5	4	5
Cornwall Tailings	17	10	5
Dolcoath	11	5	6
Geevor (10s.)	5	1	1
Gopeng	27	27	29
Mawchi	20	7	12
Pahang Consolidated (5s.)	7	7	7
Renong Dredging	36	20	25
Tekka	55	55	54
Tronoh	26	26	30

* Denomination of shares recently changed from £5 to £10.

† Denomination of shares recently changed from £1 to 4s.

METAL MARKETS

COPPER.—The market has been strong throughout the month. The turnover of standard on the Metal Exchange has been considerable, and the dealings have been animated. The advance registered is about £7, from £74 to £81 for spot, and as the rise is accompanied by a huge decrease in visible supplies there is little reason to suppose that the market is artificial or to look for an early decline. Producers are having heavy demands made on them, especially for early delivery, and even for far forward delivery sales are reported at full prices. In America 20 cents has been realized for electrolytic, and £99 in this country. As shipping facilities are not becoming more abundant, and the demand seems likely to continue, there is little prospect of producers being forced to moderate their demands.

Average prices of cash standard copper: November 1915, £77. 16s. 10d.; October 1915, £72. 13s. 7d.; November 1914, £52. 9s. 5d.

SPELTER.—Prices rose uninterruptedly from £82-£72 to £100-£90, but have since fallen again to £89-£79. America commands the situation, which is rendered the more complex by the enormous demand there for brass and in the Allied countries for munitions, by the increase of plant in America, the decline in the galvanizing trade here, and finally by the extreme difficulty of transport. Deliveries are much behindhand. Inquiry is chiefly for early delivery, business for forward being neglected. American sellers, however, seem unable to quote for shipment earlier than February-March.

Average prices of good ordinary brands: November 1915, £85. 6s. 4d.; October 1915, £66. 10s. 11d.; November 1914, £24. 14s. 10d.

LEAD.—The market continues to show undiminished strength, and prices have advanced with almost every deal closed on the Metal Exchange. Consumption for ordinary purposes has fallen off to meagre dimensions, yet the figures of importation shown by Board of Trade returns evidence enormous increases. On the other hand the exportation of Spanish lead is declining heavily, and it is to be feared that unless America, against expectation, appears as a heavier seller than she has been for months past, a considerable shortage may develop in this country. The month opened with prices at £25 to £24. 5s., and closed at £28 to £27. 10s., after £28. 10s. to £28.

Average prices of soft foreign lead: November 1915, £26. 2s. 9d.; October 1915, £23. 19s. 9d.; November 1914, £17. 19s. 9d.

TIN.—Considerable animation prevailed in this market during the early part of the month, and prices were carried up at one time to £176. 10s. for three months, and £181 for cash. Prices have since receded, and at the month's close were no better than £168. 10s. cash and £168 forward. The rise, however, has not expended itself, and a further increase is looked for in the near future. American consumption is now on an unprecedented scale, estimated at 5000 tons per month. The sales on the London market have been large, and more interest is shown than for many months past. Statistics show an increase of 2000 tons in the visible supplies, due chiefly to the large shipments from the East. These are likely to decline, whereas the American deliveries are increasing. Stocks there are small, and spot metal commands a considerable premium well over London parity. This premium seems likely to increase, as some delay is being experienced in the arrival of supplies due to the submarine menace in the Mediterranean, interfering with the voyage of tin-laden vessels and the difficulties in the way of export from London.

Average prices of cash standard tin: November 1915, £167. 18s. 5d.; October 1915, £151. 16s. 2d.; November 1914, no quotation.

ANTIMONY. — This metal continues to be very scarce and prices are nominal, say £120 per ton. Chinese crude is quoted at £80 per ton. The development of antimony deposits in the western states of America and in the Transvaal proceeds.

QUICKSILVER.—Spanish quicksilver is quoted at £17. 10s. per flask of 75 lb. In the United States the price is from $100 to $110. It is expected that the Spanish Government will fix a maximum price for the output of the Almaden mines.

BISMUTH.—10s. per lb.

COBALT.—8s. per lb.

CADMIUM.—7s. per lb.

PLATINUM.—The price continues to rise, and it now stands at 210s. per oz., nominal and subject to negotiation. The embargo on the export of platinum from England, France, and Russia is causing great inconvenience in America, where the supplies now come almost entirely from Colombia.

ALUMINIUM.—The market continues within very narrow limits and the quotation is nominal at £200 per ton. Spot metal is scarce in America and transactions have been recorded at 60 cents per lb.

NICKEL.—There is no free market for nickel in this country, and the nominal price remains at £225 per ton. The American price is 45 to 50 cents per lb.

CHROMIUM.—The quotations of New Caledonia, Rhodesia, and Beluchistan ore remains as last month, being 120s. to 130s. per ton for 47 to 55% material, on the basis of 50% chromic acid. Ferro-chrome, 4 to 10% carbon, £28 to £35 per ton, basis of 60%; special brand less than 2% carbon, £86.

MOLYBDENUM.—All Australian supplies of molybdenite are now bought by Dalgety & Co. for the British Government at the rate of 105s. per unit for ore averaging 90% Mo_2S. Ferro-molybdenum 65 to 80% molybdenum, 18s. per lb.

TUNGSTEN.—This metal is still under control of the Government at 55s. per unit. In America the prices are much higher, as much as $40 per unit having been paid. Ferro-tungsten 80 to 90% low carbon, 5s. 8d. per lb. Tungsten metal powder 96 to 98%, 5s. 10d. per lb.

MANGANESE.—No change is to be recorded in the quotations for manganese ore, 20d. per unit being the quotation for Indian ore. Supplies of ferromanganese are still allowed to go fairly freely to the United States, but ironmasters there are keenly alive to the fact that they ought to develop home resources.

IRON.—The supply of iron and steel is not equal to the demand and the prices continue to advance. There have been, however, some fluctuations due to the activity of speculators. No. 3 Middlesbrough pig iron is quoted at 72s. 6d. per ton, as compared with 68s a month ago. Hematite pig is in special demand and the quotation has advanced from 100s. to 130s. Steel rails are quoted at £9. 12s. 6d., and ship-plates at £11. Spanish ore continues to rise and is now at 35s. per ton.

SILVER.—About the middle of November there was a sudden upward movement in silver and the quotation is now 27d. per standard ounce as compared with 24¼d. a month ago. Last month we recorded the absence of available stocks in London. This condition aroused buying orders in India and China, and as the buying by the British Government was continued, the higher prices were strengthened.

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,998	363,826	8,794,824	37,358,040
Year 1914	8,033,567	344,570	8,378,139	35,588,075
January 1915	689,817	25,167	714,984	3,037,058
February	653,213	23,008	676,221	2,872,406
March	727,167	26,768	753,935	3 202,514
April	717,225	26,855	744,080	3,160,651
May	737,752	25,796	763,548	3,243,347
June	727,924	27,356	755,280	3,208,224
July	742,510	27,845	770,355	3,272,258
August	749,572	29,191	778,763	3,307,975
September	749,235	27,515	776,750	3,299,423
October	769,798	27,833	797,631	3,388,122
November	753,605	27,408	781,013	3,317,534

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
July 31, 1914	167,006	9,257	13,656	189,919
August 31	168,851	9,485	—	178,316
September 30	169,619	9,389	—	179,008
October 31	170,438	9,212	—	179,650
November 30	166,039	8,990	—	175,029
December 31	164,650	8,704	—	173,354
January 31, 1915	172,331	8,675	—	181,006
February 28	180,422	8,494	—	188,916
March 31	185,239	8,216	—	193,455
April 30	186,941	8,418	—	195,359
May 31	183,961	8,857	—	192,818
June 30	184,155	9,019	—	193,174
July 31	190,026	9,371	—	199,397
August 31	196,866	9,943	—	206 809
September 30	204,833	9,743	—	214,576
October 31	210,017	9,513	—	219,530
November 30	210,068	9,432	—	219,500

Cost and Profit on the Rand.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Year 1912	25,486,361	29 2	19 3	9 11	12,678,095
Year 1913	25,628,432	27 9	17 11	9 6	12,189,105
Year 1914	25,701,954	26 6	17 1	9 0	11,553,697
January 1915	2,237,748	25 10	17 5	8 3	920,194
February	2,077,792	26 4	17 11	8 4	867,782
March	2,366,392	25 9	17 4	8 4	985,511
April	2,289,002	26 4	17 5	8 9	996,846
May	2,416,966	25 8	17 0	8 6	1,031,220
June	2,346,493	26 1	17 2	8 8	1,017,908
July	2,395,397	26 1	17 4	8 7	1,027,332
August	2,418,447	26 2	17 2	8 9	1,056,854
September	2,413,863	26 2	17 4	8 7	1,030,853

The above are the official statistics published by the Transvaal Chamber of Mines. The profit available for dividends is about 70% of the working profit.

Production of Gold in West Africa.

Year 1912	Year 1913	Year 1914	Oct. 1915	Year 1915
£1,497,179	£1,634,700	£1,727,044	£141,771	£1,426,012

Production of Gold in Rhodesia.

Year 1912	Year 1913	Year 1914	Oct 1915	Year 1915
£2,707,368	£2,903,267	£3,530,207	£339,967	£3,178,630

Gold Output of India.

Year 1912	Year 1913	Year 1914	Nov. 1915	Year 1915
£2,265,094	£2,299,315	£2,340,259	£192,714	£2,161,867

Production of Gold in Western Australia.

	Export oz.	Mint oz.	Total oz.	Total value £
Total, 1913	86,255	1,227,888	1,314,143	5,582,140
Total, 1914	51,454	1,181,520	1,232,974	5,237,308
January 1915	561	98,196	98,757	419,495
February	607	103,661	104,258	442,900
March	1,829	91,872	93,764	398,282
April	1,017	101,592	102 609	435,853
May	2,311	101,359	103,670	440,360
June	1,273	100,036	101,309	430,333
July	555	98,859	99,414	422,271
August	1,079	99,941	101,020	429,103
September	2,019	100,833	102 852	436,885
October	2,346	100,238	102,584	435,747
November	797	99,206	100,003	424,783

Other Australian Gold Production.

	1913	1914	Nov. 1915	1915
	£	£	£	£
Victoria	1,847,400	1,740,300	115,300	1,282,400
Queensland	1,118,610	1,011,310	77,780	977,390

Exports of Copper from United States

(Reported by United States Customs).

Month	Long Tons	Month	Long Tons
July, 1914	34,145	March, 1915	29,725
August	19,676	April	20,481
September	23,866	May	25,785
October	28,995	June	15,751
November	20,170	July	16,812
December	16,830	August	16,289
January, 1915	28,197	September	14,327
February	12,066	October	26,153

Nigerian Tin Production.

In tons of concentrate of unspecified content.

Year 1912 tons	Year 1913 tons	Year 1914 tons	Oct. 1915 tons	Year 1915 tons
2,532	5,032	4,832	511	4,241

Production of Tin in Federated Malay States.

Estimated at 70% of concentrate shipped to smelters.

1911 tons	1912 tons	1913 tons	1914 tons	Oct. 1915 tons	1915 tons
43,967	48,250	50,128	49,042	3,797	39,837

Sale of Tin Concentrate at Redruth Ticketings.

	Tons	Value	Average
Year 1911	6151½	£702,599	£114 4 5
Year 1912	6492	£831,908	£128 5 6
Year 1913	6186	£744,268	£120 2 6
Year 1914	4987	£432,437	£86 14 3
January to June 1915	2826	£261,958	£92 13 10
July 5	202	£18,721	£92 13 5
July 19	204½	£18,102	£88 10 5
August 3	177	£15,069	£85 2 9
August 16	171	£14,098	£82 9 0
August 30	156	£12,935	£82 18 5
September 13	149	£12,554	£84 5 1
September 27	171½	£14,459	£84 6 3
October 11	166	£13,620	£82 1 0
October 25	164	£13,981	£85 5 0
November 8	175	£15,687	£89 12 9
November 22	174¾	£16,842	£96 7 8
December 6	182¼	£16,803	£92 4 0

Imports of Tin Concentrate into United Kingdom.

	November		Year 1915	
	Tons	Value	Tons	Value
		£		£
South America	1,186	89,441	30,315	2,510,128
Other Countries	422	34,776	8,492	776,414
Total	1,608	124,217	38,707	3,286,542

REVIEW OF MINING

Introductory.—South African affairs are attracting much attention in London these days and we give appropriate space to them this month. The improved position of many of the Rand companies is gratifying, and interest in the Far East Rand is growing. Daggafontein has been financed by the joint efforts of Henderson's Transvaal Estates, which has all the time stood behind Daggafontein, the Consolidated Mines Selection and Central Mining and Investment. A new company is to be organized, the old shares go in at the rate of three for one, and £100,000 in new capital is provided now with provision for £400,000 in 6% convertible bonds to be issued when needed. Daggafontein, it will be remembered, has a shaft already down, but had to suspend operations last year; thus an excellent opportunity has lain fallow until financial conditions were adjusted. More regarding the district will be found in the paper by Dr. E. T. Mellor that we print this month. The second week in December Tanganyika shares enjoyed a short-lived spurt on the London market, due to a favourable report from Vice-Consul G. B. Beak on the Benguella railroad and reported American buying said also to have extended to Geduld. Steps are being taken to resume washing at Kimberley, though mining will not be resumed just yet. In Canada the $50,000,000 government loan was so heavily over-subscribed that the amount to be issued was doubled and still there was not enough to go round. Both Canada and the United States had excellent crops this season and are doing well. Shipping is so scarce that there is a freight congestion around New York and a railway embargo on export shipments is proposed. Mexican conditions are improving, though slowly. Russian mines are busy and new plant is the order of the day at each. Irtysh presents a particularly encouraging report. Burma Mines continues to develop good ore at depth, and at Tavoy the Government has been asked by the Imperial authorities to take active steps to stimulate wolfram production. The Australasians are showing a determination to 'go it alone' in a mining way. The Talisman is returning to New Zealand, the English company being dissolved, and the Broken Hill companies, with the sympathetic assistance of the Australian authorities, are building up a large smelting industry. Everywhere industry is recovering from the paralysis of war and at least beginning to get ready for the long years after.

Transvaal.—The output of gold on the Rand during November was 753,605 oz., and in outlying districts 27,408 oz., making a total of 781,013 oz., worth £3,317,534, as compared with 797,631 oz., worth £3,388,122 during October. The number of native employees on November 30 was 210,068, as compared with 210,017 at the end of October and 166,039 a year ago.

The quarterly report of the Bantjes for the period ended September 30 affords unpleasant reading for shareholders, for the poor results obtained by development during the last two years are now being reflected in the monthly returns. Development on the South Reef is to be abandoned, and attention is to be centred on the Main Reef Leader. The amount of development done will depend on the current profit earned by the mine, but owing to the decreasing number of working faces and the diminishing assay-values, the amount will necessarily be small. The sinking of the main incline shaft is being suspended. An arrangement has been made with the adjoining mine, the Main Reef West, to test the Leader by means of a drift from the lowest level of the latter, which is about 600 ft. deeper than the lowest in the Bantjes. Expenses have been reduced all round, the directors setting an example by taking half fees.

The Simmer and Jack has ore reserves which will last for about two years from this date. Only a small part of the property remains to be developed. Large amounts of ore left in pillars are available for extraction, but no estimate can be given as to their extent.

The visit of Mr. S. B. Joel to South Africa, after so long an absence, portended an investigation of the policy of the Barnato group in connection with either gold or diamond mining. It is stated that he has advised the re-starting of washing operations on the accumulated blue ground, in order to meet the demand for diamonds in America, but there is no intention at present to re-open the mines.

The election of Mr. H. C. Boyd to the boards of the Geduld and Modder Deep companies indicates that the Central Mining & Investment Corporation has taken an interest in these two promising ventures of the Goerz group. Mr. S. B. Joel has been elected to a seat on the board of Springs Mines, indicating the financial interest taken in that company by the Barnato group.

Rhodesia.—The monthly output of gold has recovered and stood at £339,967 for October as compared with £321,085 the month before. Eldorado, Gaika, Giant, and Lonely Reef showed advances; but at Jumbo and Thistle - Etna the production decreased, as might be expected considering the state of the reserves. There seems to be little hope for finding a continuation of the faulted lode at the Giant, in spite of much geological assistance.

The reports from the Lonely Reef mine indicate that the developments at depth have been decidedly encouraging recently. On the south drift from the cross-cut on the 13th level the average assays along the 130 ft. driven during the quarter ended September 30 gave nearly 1 oz. of gold over a width of 5 ft. In a winze between the 12th and 13th levels the assays averaged 36 dwt. over 6 ft. The cross-cut on the 15th level has reached the lode, and at the point of intersection the assay was 37 dwt. over 4 ft. 6 in.

West Africa.—The output of gold during October was worth £141,771 as compared with £135,744 in September and £159,410 a year ago. Abbontiakoon, Abosso, and Prestea Block A showed slight increases, but the output at Ashanti Gold Fields and Taquah was rather less.

The position of the Ashanti Goldfields Corporation continues to be excellent. It is true that the reserves at the main workings are approaching exhaustion, and that the ore at Ayeinm is of so low a grade as to yield little profit; but on the other hand the Obuasi shoot responds in a most gratifying manner to development in depth, and the outlook is even better than a year ago. Levels 14 and 15 have been commenced during the past year, and a station is now being cut at the 16th level. The reserve in this shoot is estimated at 266,900 tons averaging 28 dwt., as compared with 213,400 tons averaging 27·3 dwt. a year ago. The monthly returns are remarkably regular. During the past year 104,634 oz. was extracted from 131,236 tons of ore, and the shareholders received £151,670, being 2s. 9d. per 4s. share. Development and stoping at this mine is rendered difficult by the softness of the country rock, which consists of the notorious graphitic schist. The stopes have to be filled as soon as possible after the extraction of the ore, and under these conditions the number of working faces is restricted. In Mr. W. R. Feldtmann the company has a safe and careful consulting engineer.

India.—The results at the Champion Reef during the year ended September 30 fulfilled the expectations based on the improvements in development during the last few years, and the dividend shows a continuance of the increase since 1909–10, when the grade of the ore suffered a serious decline. The ore crushed amounted to 211,368 tons and the gold won was worth £545,338, out of which £147,333 was distributed as dividend, being at the rate of 56⅝%, as compared with 53⅛% the year before. The best year was 1905, when £825,263 was obtained from 240,987 tons, and £416,000 was distributed as dividend. The total production since the start in 1892 has been £11,692,875, won from 3,607,487 tons, and £4,304,966 has been distributed as dividend. Unfortunately another period of lower returns appears to be approaching, for though the tonnage of the reserve has been increased, one part of the mine, the Glen section, shows a fall in the grade of the ore developed, and a reduction in the monthly returns of gold seems probable.

Australasia.—Further sales of zinc concentrate to America are reported by the Amalgamated Zinc (De Bavay's) company, the contract calling for 50,000 tons during the second half of 1916. The company has also sold 4000 tons to Japan for shipment not later than March.

The position at the Yuanmi gold mine near Sandstone, in the East Murchison district of West Australia, has improved substantially during the last few months. A year ago it was feared that the outlook was dark as regards development at depth. Recent work, however, on the 5th level has proved the existence of additional bodies of ore. On the 5th level ore-shoots aggregating 458 ft. in length, and averaging 48s. over $4\frac{1}{2}$ ft. have been proved, and the drifts at both ends are still in ore. These results are better than those obtained on the 4th level. On the 6th level the cross-cut from the shaft has reached the orebody, and the small amount of driving done so far indicates that the lode is of much the same width and assay-value as on the 5th level. These results will encourage the engineers to press development, and probably also to increase the capacity of the roasting plant.

Gold-stealing continues rife at Kalgoorlie. This time the victim is the Lake View & Star, and the amount involved is so large that the final dividend for the past year has been reduced from 6 to 5%. That the abstraction of gold from metallurgical plant has become a fine art at Kalgoorlie was evidenced by the account we gave of a specific case in our issue of June a year ago.

The terms of the deal between Mount Lyell and the group of companies owning deposits at Rosebery, Tasmania, have been published. The three companies are the Tasmania Copper Co., the Hercules Gold and Silver Mining Co., and the Primrose Mining Co. The companies give the Mount Lyell options for nine months, during which experiments with regard to treatment will be undertaken. Small cash payments are given for the options, and if the options are exercised the Mount Lyell has the choice of absorbing the companies by the issue of shares or of forming a separate company. The first two named have fairly heavy liabilities. The ores are chiefly intimately mixed complex sulphides.

The Briseis Tin & General Mining Co. reports that the Ringarooma property, Tasmania, is estimated to contain 4500 tons of black tin in 7 million cubic yards of gravel. Approximately 1,360,000 cubic yards of overburden consisting of columnar basalt has to be removed. The development of this property has been greatly delayed by scanty rainfall, which also interfered with the sluicing operations at Briseis and Krushka's Flat. Briseis is now finally exhausted, and there is not much ground left at Krushka's Flat. The company has recently acquired an interest in the New Reynolton Collieries Ltd., which is developing an anthracite property in Pembroke, South Wales.

We mentioned in our September issue that a proposal had been made to transfer the control of the Talisman Consolidated from London to New Zealand, owing to the majority of shareholders residing there objecting to paying the English income tax. A definite plan is now before shareholders, involving the winding up of the English company, and the formation of a new company in New Zealand having identical shares. At the mine, there has been trouble with the contractor who has the work in hand at the 15th level, so the mill has been closed and the repairs usually done at Christmas have been commenced. Milling will be resumed when other men are available for the 15th level.

A few months ago Dr. Arthur Wade reported adversely on the prospects of finding oil in the coastal regions of South Australia. A similar expression of opinion with regard to the adjacent coasts of Western Australia has been published by Mr. H. P. Woodward, the Assistant Government Geologist. This opinion was first formed in 1902, when the Chief Government Geologist, Mr. A. Gibb Maitland, made an investigation, and the visit of Mr. Woodward was undertaken owing to pressure in certain quarters where it was hoped that after the lapse of 13 years a different view might be taken by the geologists. Mr. Woodward agrees with Dr. Wade that the asphaltum found on the beaches of the south coast of Western Australia, as on the coast of South

Australia, consists of animal or vegetable remains cast up by the sea, and that the iridescent films on inland waters are composed solely of hydroxide of iron.

Malaya.—The Pahang Corporation presents a remarkably good report for the year ended July 31. It is the only tin producer that shows an increased profit during a period of suspension of the market and of low prices for tin. In spite of these drawbacks, the profit rose from £71,242 to £106,901. The amount of ore treated and of concentrate produced was greater, the yield being 2538 tons from 160,000 tons of ore, comparing with 2015 tons from 137,055 the year before. In addition 126 tons of concentrate was obtained from alluvial mines. Development work was restricted; nevertheless about 200,000 tons was disclosed. A level at 700 ft. has been opened, and a small amount of work done; so far the width and content of the lode are less than in the 500-ft. and 600-ft. levels. It will be remembered that in the latter two levels the lode was wider, longer, and richer than in the levels nearer the surface.

The Chenderiang Tin Dredging Co. owning alluvial tin ground in Perak, started operations with a Simons dredge in April last, and during the six months to the end of October treated 572,300 cubic yards for a yield of 172 tons of tin concentrate, being an extraction of ⅔ lb. per yard. An interim dividend at the rate of 2½ per cent. on an issued capital of £92,500 has been declared. The Tekka, a Werf Conrad, dredge has just started, and reports as to its performance are very satisfactory.

Russia.—The Russian Mining Corporation reports that the pumping plant at the Zyrianovsk mine on the Altai Concessions has been put into commission. It is expected that the old workings will be freed of water by the end of March. Drilling has disclosed what is apparently a new orebody, the thickness of sulphide ore being 12½ ft., and that of lower grade ore 15 ft.

We hear that suitable arrangements have been made by private negotiation so that the Sissert will be able to proceed with equipment and operation of the new Degtiarsky mine, and probably with expansions in other directions. This is good news for the shareholders, who are thus rescued from the embarrassment of having a good orebody that could not be brought to production promptly because of an over-generous dividend record.

Irtysh affairs are in most satisfactory condition. The Technical Committee issued a report on December 8 estimating the ore reserves at 3,174,000 tons in the Ridder mine, and the profit at £10,800,000. It is to be noted that this is based upon lead at £16, zinc £20, and copper £60, London prices, so that the increase represents additional ore found and not a mere marking up of the old reserve. The test mill has been made into an operating plant and will have sufficient capacity to supply two or three blocks of the zinc furnace, equal to 3200 to 4800 tons of spelter per annum. It is hoped to make some spelter by the end of the year and to reduce lead by the autumn of 1916. Last month we allocated to the Kyshtim a railway that really belonged to the Irtysh. We are glad to restore it to its proper owners, and to report that transportation as well as mining and metallurgical problems at the Ridder are being rapidly solved.

Interesting rumours regarding impending changes in working methods at the Lenskoi mines have been circulating in Petrograd and London and, while details will not be known until the report is issued next month, it is evident that the company is about to take up seriously the problem of handling the large bodies of low-grade gravel found on the estate. That the supply of high-grade was bound to be exhausted at even so great a mine as the Lenskoi has long been recognized, and two years ago Mr. C. W. Purington was called in to advise. In July we gave some account of the good results following from winter washing, and we understand that he recommended many other improvements. His forceful insistence upon changes led to the appointment this year of a special technical committee to examine and report on the whole matter jointly to the Lena and Lenskoi companies. This committee investigated matters at the mines and consulted with directors in Petrograd. Messrs. H. M. Payne and A. F. Gernet, forming a majority, have been in London this month, and though their report is not yet ready we infer from inquiries directed to manufacturers that a beginning at dredging is to be among the recommendations made. Apparently, too, deep ground and hard conditions are to be met. Mr. W. E. Thorne has been drilling for the company this season and the actual conditions, whatever they may be, should be well known. Mr. Payne is consulting engineer for the Boyle companies operating in the Klondyke, and so knows of the work done by the large dredges of the Far North. Mr. Gernet is affiliated with the Russian Mining Corporation and other companies having wide interests in Russia, and so knows local conditions well. We are glad to see the Lena company preparing to attack seriously its large problem. We could wish, however, that a start might have been made earlier, as the temptation now will undoubtedly be to jump at once into operations on a scale which will greatly increase the difficulties. The Lena goldfields are large and still rich, and we expect to see much gold come from them through many years yet.

United States.—Our New York correspondent discusses the financing of the Kennicott and the Cerro de Pasco, two most significant events, as they point to a further development of a public market in America for mining shares. Hitherto the big properties have been financed by private negotiations. Our San Francisco correspondent tells of the search for rare metals and other things which attract attention on the sun-lit coast of California. Later advices say that Mr. W. J. Loring, who represents Bewick, Moreing & Co., encouraged by the success of the Plymouth and the looks of the Montezuma, is undertaking development at the south end of the Mother Lode as well. He has taken hold of the App, Dutch, and Harvard mines, near Jamestown. The App is a large low-grade property that has been in the hands of a receiver. The Dutch and Harvard are smaller but richer mines nearby, which have managed to keep going and make money despite the limited scale of operations. A combination of the three offers interesting possibilities, and we hope that the success that crowned Mr. Loring's efforts at the north end of the lode may be duplicated here. General industrial conditions throughout the United States are improving, as may be indicated by the fact that the output of the Lake Superior iron ore mines for next year is estimated at 60,000,000 tons.

Owing to the continuance of labour disputes, the Arizona Copper Company produced no copper during November. Serious damage has been done to the concentrating plant by an incendiary fire, but the extent of the damage is not yet ascertainable.

Alaska. — According to announcements made at Juneau, the new Alaska-Juneau 8000-ton mill will employ ball-mills in place of stamps as at first contemplated. The officers of the company have been experimenting this year on both Juneau and Treadwell ore, using the same mill but a different ball from that employed at Inspiration. Results have been so successful that it is now said that following four gyratory and two jaw crushers, twelve 6 by 8 ft. ball-mills will be used, followed in turn by twelve 7 by 10 ft. tube-mills, 48 roughing and 120 finishing tables. The mill will be in four units, of which the first is expected to begin work early in 1917. The present mill has 300 tons capacity. Whether the new system of crushing will be applied later to the Treadwell properties has not been stated. At the Perseverance mine of the Alaska Gold Mines a 'horse' of barren rock was encountered which was of such size as to interfere with the output even of that great mine. Mr. Jackling has issued a statement reminding the shareholders that it is better practice to take the ore as it comes than to hunt out the higher grade in order to make a showing. This is especially true in the case of these large mines which are worked by caving. In other particulars the enterprise does well, as the costs are 60 c. per ton as against the estimated 75 c., and the tailing loss is only 20 c. as against 25.

Mexico.—Conditions improve though slowly. Railway communications from Vera Cruz through to El Oro have been re-established, and supplies are going in. Trains are also running from Laredo to the City of Mexico. Other main lines remain broken, and even on those now open service is slow and uncertain owing to poor track, temporary bridges, and limited and defective rolling stock. One line which had 78 locomotives at the beginning of the war has 8 in service now. The roads were to have been returned to the companies on the first of December; whether this was done is not known. At any rate, industry cannot resume on any large scale until the roads are rehabilitated, and that means that the Mexican Government must come to terms with the bondholders, the real owners of the roads. These will naturally demand guarantees, and Carranza has not as yet shown that large vision which would suggest a prompt acceptance of the situation. The smelting and larger mining companies are also holding back until some definite understanding is reached as to future taxes. The decree, of which we present a translation in the Précis, is significant, as it indicates some disposition to pause and discuss matters on the part of the authorities. Villa remains a trouble only in Sonora. By means of Carranza troops sent through the United States he was defeated at Naco, but his forces so dominate the situation in the interior of the State, that recently the El Tigre mine was the only one running.

Baja California has remained nearly undisturbed through the whole trouble, and it is a rich mineral country. The El Boleo copper mines at Santa Rosalia and the silver and gold mines between Triunfo and Totas Santos are well known. It is not so generally appreciated that large bodies of low-grade ore occur on the peninsula and may become the basis of an important industry. In general, the time for resumption of mining on a large scale in Mexico seems not to have yet arrived.

Colombia.—The reorganization of mining and metallurgical methods at the gold mines of the Frontino & Bolivia company is now bearing fruit, and the ordinary shareholders received 10% dividend for the year ended June 30. The sinking of the main shaft has been resumed. Scarcity of labour caused a slight decrease in the tonnage treated and in the amount of development. The output of gold was 26,938 oz. from 25,971 tons, and the ore reserve is estimated at 28,700 tons averaging 1 oz. per ton. The new cyanide plant is expected to be ready this month.

The Tolima Mining Company is the victim of one of the vagaries of the war, which causes rich silver-lead ore to be worthless temporarily. This company has been mining in Colombia for many years, and has shipped galena concentrate containing 400 to 500 oz. silver per ton to England. The English smelters are at present under Government control, and only lead is wanted, so that the bullion refineries are closed. The company will have to borrow money to continue until the product once more becomes realizable.

Spain.—The Huelva Copper & Sulphur Co. and its predecessors have operated a pyrite property in the south of Spain since 1896. After many years of ill-fortune, the directors appointed Mr. H. F. Collins to the management, and by his advice a smelter was erected, so that copper should be produced, instead of pyrite being shipped. Mr. Collins' policy appears to proving successful, in spite of the low grade of the ore. The first complete year of smelting has given 1222 tons of blister copper from 49,508 tons of ore, with which was smelted 13,773 tons of old slag and matte. In spite of adverse conditions caused by the war, a profit was earned, and it has been possible to put the finances of the company on a firm footing. The dispute as to the ownership of outlying ground has been finally settled by the sale of the property in question, so that the company is freed from the incubus of threatened law-suits.

Notable Deaths.—Nicol Brown, who died last month at the age of 73, was not only a capable business man and company administrator, but he had an excellent acquaintance with practical geology and mining. He was well known in connection with the copper mines of southern Spain. Most people will probably have forgotten that he was a pioneer in Transvaal gold mining, having been instrumental in 1883 in developing the properties at Pilgrim's Rest, now belonging to the Transvaal Gold Mining Estates, of the board of which he was a member at the time of his death. To us, as journalists, he was a kind friend, ever ready with help and advice.—Arthur Gifford has died at the early age of 45. For ten years he was manager of the Mysore gold mine, and retired a year ago on account of ill-health. He came of a family that has provided many trustworthy and able members of the staff of John Taylor & Sons.

EDITORIAL

TO follow a biblical injunction is usually a safe rule, but the critics aver that the chairman of the Consolidated Gold Fields interpreted too literally the particular one which refers to transfer of knowledge from the right to the left hand when he passed this year's depreciation accounts. There is another command that refers to a good deed not being hidden under a bushel.

SEPARATION of wolfram from cassiterite has usually been accomplished by means of magnetic concentrators. In connection with munition work here in London large quantities of concentrate are now being cleaned by the Murex process, which proves to be especially suitable.

MESSINA shareholders listened to a much more cheerful speech from the chairman this year than might fairly have been anticipated in view of the situation a year ago. The company has profited greatly by the rise in the price of copper, but also from the excellent management both technical and financial. The floating debt is gone, there is a chance of recovering part at least of the lost funds, extraction has been increased remarkably, and, if the ore reserve is disappointing, it is true, as the chairman said, that the engineers have done everything "except to put the ore in the ground, and they cannot be expected to do that." We write elsewhere about the method used by Mr. Kuehn in estimating the reserve, and we would add that in part the difference between his and earlier estimates arises from taking unsorted rather than sorted ore as the base. As to the future, even the company officials cannot speak positively. The present policy is one of rapid exhaustion, a proper enough policy in view of the high price of metal and the enormous difference this makes in profits. What may lie beyond cannot be foretold. Messina owns a large area, of which only a small part has been prospected, and that with excellent results. There is no reason why other ore-shoots may not be found, and those now worked, while smaller in depth, are by no means as yet fully developed.

DO YOU realize that every day in Northern France your fellow miners, men who have worked with you or for you, are being hurt or are barely escaping hurts while engaged in tunnelling under the enemy trenches? That in silence, wet, and danger far beyond that of ordinary mining, they are spending their lives and energies to keep the enemy from breaking through and on into our homes? Christmas, and the long cold wet days following, will be none too cheerful 'somewhere in France' this winter. Don't you want to make it a bit more comfortable for the boys at the Front, to let them know that those at home are thinking of them? If you do, send your box of comforts to Captain Ralph Stokes, of the 174 (Tunnelling) Company, Royal Engineers, B.E.F., or if it is more convenient, send us your bundle or your money. Just ring us up or drop us a line and tell us how much to charge to your account, and we will do the rest. If Christmas has gone before this appeal arrives, do not let that deter you, as there will be many gloomy days to follow. Don't let the other soldiers think that the miners have no friends.

MINE managers responsible for properties yielding both high-grade and low-grade ore are often in difficulty not only in estimating their reserve at the end of the year, but with regard to the question of what it is proper to announce as each little body of high-grade ore is found. This difficulty is especially large in the case of the Cobalt mines in which, broadly speaking, the reserve consists of many small rich bodies of ore. Each is quickly worked out and the individual 'veins' are constantly being exhausted as the work proceeds. More must be found to keep the work going, and the experienced manager soon learns to expect a certain average number of discoveries as he explores his mine. The finding of these rich spots is all in the day's work, and no one or two or three of them materially alters the intrinsic value of the shares of the company. If he announces each as found, and does not carefully note the corresponding exhaustion of some earlier found vein, the public and many of the shareholders are misled quite as much as if he accepts each discovery as in the nature of things, one of the events already taken into his plans, and says nothing about it. The matter has been under discussion in the *Statist*, which criticized the four-weekly reports of the Canadian Mining Corporation and called for figures of high-grade and low-grade separately, with total ounces and price. At present the figures given are for profits, expenses, and footage. The irregularity in returns represents the amount of high-grade marketed, footage remaining steady, but it is impossible to deduce exact figures because of profits from a reduction company entering the accounts. The very purpose of organizing the Corporation was to get stability through averages. To emphasize the high-grade would introduce the element which it is purposed to minimize. Perhaps a working compromise would be to state the reduction company profits separately and to give total ounces and price.

The Gold Fields as an Investment Company.

In examining the report of the Consolidated Gold Fields or listening to the speech of the Chairman at the shareholders' meeting, one is struck with the wide scope of its operations. Originally based upon gold mining on the Rand, and still dominating a number of great mines there while holding minor interests in many others, the Gold Fields report also carries us to Rhodesia, West Africa, the United States, the Klondyke, Mexico, Colombia, and Trinidad. In all these countries important mining operations are conducted. Even this does not exhaust the list, as there are minor investments in shares and bonds not represented above. Another interesting feature is that whereas the company originally dealt with gold quartz mines it now holds interests in both gold and platinum placers, in copper mines, oil wells and leases, power companies, forests, and chemical industries, and owns securities of such enterprises as the General Motors Company. From gold mining the Gold Fields has become truly a general investment company of the type known in the United States as a Trust company, that is, one which is authorized to undertake business usual for a private banker rather than for an ordinary public bank. It is a relatively new form of organization combining the flexibility of private business with the advantages of company organization. It is interesting to see how the great Rand houses, for the Gold Fields is not alone in following the new trail, drift into becoming investment rather than mining companies. We doubt if the general public fully realizes this trend. Mining men know that with the best of skill and foresight, it is still impossible always to pick winners among the prospects and young mines demanding capital. Some are sure to fail to justify the expenditure, however promising they may seem at the first. It is also a fact of observation that the individual small investor will seldom so apportion his funds to several companies as to average his risk. If he would do so, mining would be the preferred form of investment, as it is possible so to average losses and still to have a share in the unusual profits which each of us hopes to win in mining. Such companies as those of which the Gold Fields is a type offer this opportunity to investors. Through experienced capable engineers and financiers, a selection is made from enterprises offering a field for investment, with full knowledge that some will prove disappointing. The funds are available because of the legal requirement that capital shall not be distributed as dividends except as shares are written down, and in honest mining capital is constantly flowing back into the treasury. Since these mine investment companies not only take shares in new enterprises but also offer shares to their own shareholders, each may plunge as he likes on a particular enterprise, or he may take what protection appeals to him by buying only the shares of the parent company. Such companies occupy an important place in mining, one that we expect to see grow. They perform a very real economic function. The success or failure of any particular one will rest upon the skill and judgment of the men in control, and their chief asset must always be public confidence, as they grow through satisfaction of their shareholders and the winning of recruits to the share lists. It is necessary that large powers be lodged with the managers, but they in turn must look to final rather than quick profits. The line between legitimate buying and selling and gambling in shares is one which is difficult to draw if a rule is to be laid down, but it is one that the heads of such companies as we are discussing must learn to draw without hesitation in each case that comes before them, or failure is inevitable. Experience has shown that market syndicates organized to gamble with other people's money come quickly to disaster. Experience has also shown that financial companies subject to the close limitations which surround an ordinary bank do not do well in mining. We must have freedom of action. This, coupled with a keen sense of trusteeship, will bring success. The houses which respect this limitation will thrive, and the others, after possibly a flash of prosperity, will fail; but the form of organization will have been justified, and the field for it in mining is almost unlimited. The first Rand mines proved so profitable that the public rushed into the market and absorbed shares on a 5% basis. This is too low for gold mining, even on the Rand, and to protect shareholders the Rand houses have had to go into other fields. Some of them have not perceived this necessity, and accordingly some still have all their investments tied directly or indirectly to the Rand. Other have ranged far, though none, we believe, so far as the Gold Fields, which protects its shareholders by spreading the risk widely. If we may offer a caution to others it would be against the twin dangers of scattering too widely either geographically or by industries. Until a sufficient number of investments are made in one country to justify a local organization such as the Gold Fields supports in the United States, overhead expense will be high, as is always true in the initial stages of an enterprise. It is better clearly to own groups of mines in a smaller number of countries than individual mines in many. The other danger is in the attitude toward enterprises not connected by the closest possible ties to mining. A power company which is incidental to the opening of a mining district is evidently in one class, while a general power company whose main customers are in cities or irrigation districts is in another. Both may present an excellent opportunity for investment, but not necessarily to the same people. When a mining group finances outside investments their attitude should be strictly that of a banker, for there are limitations to the technical knowledge of even a mining engineer. To enter fields outside mining spreads the risk in a new way, but also introduces dangers of a new sort. It is the difference between general and special insurance, and the latter has proved, we believe, the more profitable. Naturally, also, knowing the needs of mining, we prefer to see money go into our own industry, and we believe that it offers the best field for a mining house. These are general questions about which we all think and concerning which we may amicably differ. Our present purpose is to call attention to the very powerful agencies growing up in our midst, agencies well designed to change the character of investment in mines from a highly speculative and risky undertaking, to an ordinary risk in a field offering exceptional but high returns.

Geology and the Far East Rand.

We print this month a second and final abstract from two most interesting papers on the geology of the Rand, read by Dr. E. T. Mellor before the Geological Society of South Africa last September. These papers are based upon studies extending over five years, conducted for the Geological Survey. They represent first fruits from the general survey of the region still in progress, and they differ from the many interesting and valuable papers already available in that Dr. Mellor's work is on the Rand as a whole, and does not depend upon any one mine or group of mines. With a nice consideration he has refrained from publication until he had studied the larger part of the area, and the two papers now made public follow and supplement an earlier one on the Lower Witwatersrand system. It is to be regretted that Dr. Mellor's maps and sections are not yet available in London, but even in their absence, those familiar with the region will be able to follow his argument and to appreciate the patient care with which the evidence upon which it is based has been dug from outcrops and original records. Limitations of space have prevented our printing his discussion of the variable beds associated with the Main Reef and Main Reef Leader, and in particular, the 'Black Bar.' These beds have given rise to much confusion and many erroneous correlations, and, on the Rand, this part of his paper will be read with especial interest. Of more general significance is his correlation of the various 'reefs' of the Far East Rand, and the proof that the workable reefs are all one which is recognized as the Main Reef Leader. Remembering that when work began at the Brakpan it was necessary to drill to prove even that a reef was present, this demonstration of the continuity of a profit-bearing reef throughout the great basin is seen to be extremely important. Dr. Mellor takes a cheerful view as to the 'patchy' distribution of the gold in this reef. As he suggests, nature has performed part of the work of concentration for the miner. Neither he, nor anyone else, probably, is able as yet to deduce a safe factor for estimating the ratio of barren to profitable ore in the basin as a whole. Nor is it possible to say what is a fair average value per ton. Brakpan experience points to 6·7 pennyweight ore; New Modder, 8·2; Modder B. finds 8·6; Government Areas, 6·5; and Springs, 10·3. The grade of the ore worked will bear some relation to working costs, but even so the general average may prove higher, just as it may prove lower, than one might assume from the few figures as yet available. At any rate the Far East Rand constitutes a great basin, 25 miles or so across, all within workable depth from the surface, containing a well-defined practically continuous reef, and the areas so far tested on a large scale have been found to contain a sufficient portion of profitable ore to make mining attractive. With the understanding of the district that is now available, in part through Dr. Mellor's studies, it should be possible to safeguard somewhat the investments made and to be made, in the Far East Rand. It should also be possible to so estimate the chances as to secure suitable terms and regulations from the Government. Unless this be done, output will drop as a result of lessening activity on the Central Rand before the necessary deep and expensive mines on the Far East Rand are brought to a producing stage.

Dust Problems on the Rand.

The problem of prevention of miners' phthisis has got into politics in the Transvaal as a natural result of the well known disposition of candidates to promise everything before election. It is regrettable that so complex and difficult a technical problem should become a political football, but it is not greatly to be deplored that any matter so vital to a country should, from time to time, attract the attention of the highest legislative body. Even the best system requires periodic inspection, and if the authorities are in any degree slack, or the regulations have not kept pace with growth in technical knowledge, the matter should be ventilated. In our discussion department, Mr. G. H. Blenkinsop expresses a somewhat pessimistic opinion of present conditions and methods. To anyone not connected with the operations, it would seem that there has been the most earnest purpose to give the maximum protection to the men who work underground. The companies and the Government have both spent large sums of money, and the regulations under which work is conducted are stringent, as much so as in any great mining district save those in Australia. It is impossible to say exactly how successful the measures undertaken have proved. The statistics furnished by the Miners' Phthisis Board are criticized locally as not affording enough data upon which to make accurate comparisons. The general impression to be gained from what has been printed, is that substantial progress has been made, and that seeming discrepancies are probably to be explained by closer inspection and the accumulated load of old cases. Certainly, however, more is known about dust now than when the present regulations were drawn up. In October we noted the admirable studies made by Dr. James Moir, and the dominating importance of the fine dust below 12 microns is a fact even yet not wholly appreciated. So too, while the first feeling of danger centred around drilling, and especially drilling dry holes, it is now known that blasting contributes much the largest amount of dangerous dust. A report of the Miners' Phthisis Prevention Committee just issued, and presented in abstract in the *South African Mining Journal* for November 6, calls attention to the fact that the use of water from mine sump or pump column may prove positively dangerous. Such water may well be heavily charged with dust particles and, if atomized through leaks at the drill, produces a fog increasing the amount of dust the men may take into their lungs. However, the Committee evidently sees no reason for pessimism, as it finds that by use of water under proper conditions and in proper amounts the dust content of the air can be reduced to such a point that it does not constitute a danger. Mr. D. Christopherson has made the suggestion that the Rand members of the Union parliament should come together in committee without regard to party lines and study the whole matter before the session. We hope they will do this, as in all such matters it is not regulation that mining companies fear, but uninformed and unnecessary regulation.

Cyanide Consumption on the Rand.

In two papers read before the Chemical, Metallurgical, and Mining Society of South Africa on September 18, this old but important subject was brought again to the front. Mr. H. A. White discussed the main topic, while Mr. H. M. Leslie spoke of the prevention of hydrolysis in cyanide solutions. Our readers are familiar with the subject, but it may be helpful to review the matter. As may well be supposed, this war has provided many problems on the Rand. The buying department of the Johannesburg Chamber of Mines some time since examined the situation with a view to discovering, if possible, a method of decreasing cyanide consumption, following similar results in connection with other supplies of which war conditions caused a shortage. The committee found that the cyanide consumption on the Rand averages 0·4 lb. per ton of ore, or roughly 5000 tons of sodium cyanide per year, costing over £1,000,000. The real questions at issue were seen to be: *(a)* Would it be possible to save cyanide by using weaker solutions; *(b)* to what extent the present cyanide consumption could be reduced. The first question was answered by the consulting metallurgists of the Rand, who, in conference, agreed that "no application of known methods could be relied upon to reduce materially the cyanide consumption in an economic manner. The results of special efforts made, when the onset of war threatened supplies, showed a loss of gold more than counterbalancing any saving in cyanide." Mr. White states that "a saving could be effected if lower cyanide strengths were possible without counterbalancing losses of gold in the residues; but that is not generally the case, and the point must be emphasized that any saving of cyanide by means of increased alkalinity, or in any other way of reducing gas losses must be partly offset by increasing amount of loss in residue moisture." The long series of experiments recorded by Mr. White brings out the following points: (1) The loss of cyanide in solutions exposed to the air is incomparably greater in pure synthetic solutions than is the case with ordinary working solutions; (2) there is a heavy loss due to exposure to air when there is little or no protective alkali present; but that the loss is much reduced when the alkali strength is not allowed to get below 0·030% NaHO; were it possible to accumulate all gas from the surface of cyanide liquors, a regeneration of cyanide by using absorption towers might be effected to the extent possibly of 28·6% of the total cyanide used.

Previous to the activities of the Chamber of Mines in connection with cyanide losses, Mr. H. M. Leslie arrived on the Rand, and was given facilities by the Rand Mines, Limited, for demonstrating his theory that very large preventable losses in cyanide occurred through contact with the air, and that the remedy was the use of his 'closed system' of treatment, which required that all tanks containing cyanide solutions should be sealed by means of covers, and the cyanide regenerated from the captured gases by means of alkali. In trials at the Village Deep, Mr. Leslie demonstrated that his process could save 0·2092 lb. of 100% KCN per ton of ore, or 54% of the cyanide loss. This loss, according to Mr. Leslie, bore out his whole contention that: *(a)* A cyanide solution undergoes gradual decomposition; *(b)* a cyanide solution evolves hydrocyanic acid; and *(c)* this decomposition is not prevented by the use of excess alkali. It was thought advisable after the completion of the Village Deep trials to give Mr. Leslie an opportunity to confirm his results by experiments on the Brown agitators at Modder B., where the contact of solutions with air was immeasurably greater than in quiescent leaching vats, and where, presumably, his process would be likely to show to greatest advantage. These trials, however, were a disappointment to Mr. Leslie. They showed a very small loss of cyanide, which he attributed to the presence of high alkalinity, made necessary by the exigencies of zinc-dust precipitation; and thus, as pointed out by Mr. White, Mr. Leslie contradicts his expressed opinion that alkaline protection is in practice useless.

A further series of investigations made by Mr. White revealed the interesting facts that "practically HCN evaporation from alkaline solutions is trifling, but that CO_2 can effect heavy losses in the absence of protective alkali," and further "that ammonia is much more readily evolved than HCN from alkaline solutions in actual works practice; but it remains a difficult problem to determine exactly what proportion of the gas losses is due to ammonia, and what to the other possible sources, hydrocyanic acid and methylamine." Mr. White is of opinion that by closing-in the vats the ammonia hydrolysis might be reduced by preventing the escape of ammonia; but, at present writing, it does not appear that any mining company has had the hardihood to adopt the very radical remedy proposed by Mr. Leslie. To put airtight covers on all leaching, slime, and solution tanks, apart from the initial expense involved, and the possible fouling of solutions due to exclusion of oxygen, would be to introduce complications in the technique of cyaniding that might easily outweigh the advantages to be gained. Under the circumstances, there would appear to be nothing to do but accept the implied view of Mr. White, and the other metallurgists of the Rand, that apart from maintaining the required alkalinity there is really no practical method known of obviating these elusive gas losses.

Sulphuric Acid.

It is a trite saying that sulphuric acid is to the chemical manufacturer what iron is in the metallurgical world. But to the general public this saying makes no appeal, for sulphuric acid is not a final product like iron, and is only a means to an end. It is not seen in our houses and highways, and to the average person it is merely a name, sometimes not even so much as that. To mining men it is more often than not a nuisance, as for instance in the case of smelter smoke or of acid mine-waters. Being a dangerous material and not conveniently stored and transported, it is usually manufactured on the spot where it is required, and manufacture precedes consumption by as short a space of time as possible. In other words, it is made according to requirements, and there is little 'free acid' on the market, if our friends in the chemical laboratory will allow us to use the term in this sense. It follows therefore that if a smelter is forced by the pressure of public opinion to make acid instead of pursuing the older and more convenient way of discharging the acid gases and vapours into the atmosphere, he is faced by a very real difficulty as regards the disposal of his by-product. He can rarely find a ready market for it, and has to create one by establishing a business that requires it as raw material. But if he cannot sell his acid or use it in the manufacture of some more saleable article, he is in a serious quandary. The producer *malgre lui* is therefore in a difficult case. On the other hand, a consumer who suddenly wants an increased supply is in almost as bad a position, and his contemplated expansion of operations may be blocked for months. This feature of the trade is well exemplified by the large requirements of sulphuric acid needed for the manufacture of high explosives, on a stupendous and unprecedented scale, for the purposes of the present war. The shortness of shells and ammunition for the British army was due in large part to the difficulty of increasing the usual acid supply a hundred fold. While new factories were being built, the uttermost parts of the earth were scoured for ready supplies. Some was secured in the United States, and its shipment gave an instance of the difficulties of transport to which we have referred, for many of the containing vessels came to grief and did damage to the ships carrying them and to the other parts of the cargo.

Sulphuric acid has so many large industrial applications that we cannot do more than indicate a few of them. The first of the big uses was the manufacture of soda products from salt by the Leblanc process, and consequently the acid works are usually found at the centres of alkali manufacture. Of recent years the introduction of the ammonia-soda and electrolytic processes has proportionately decreased the amount of acid used for this purpose. Similarly the amount of sulphuric acid consumed in connection with an adjunct of the Leblanc process, that is to say, the release of chlorine from bleaching powder at bleaching works, has suffered, seeing that nowadays much of the chlorine is supplied in liquid form instead of as bleaching powder; and moreover hypochlorites are used largely in bleaching, instead of free chlorine. Sulphuric acid is employed in the manufacture of most of the other acids, which in turn are used as bases (again apologizing as to terms to our chemical friends) of multitudinous compounds. The list of commercially valuable salts of sulphuric acid is a long one, but we may specify as examples sulphate of ammonia and sulphate of copper. It is used in the production of soluble superphosphate from insoluble phosphate in bones and rocks, in the preparation from starchy materials of sugars used in brewing, in oil refining, in the production of aniline dyes and high explosives. All these manufactures call for large supplies of acid.

As regards the raw material from which the acid is made, Spanish pyrite still holds first place, and then comes native sulphur mined in Sicily and Louisiana. Other sulphides such as blende are employed, but usually only when the acid is a by-product. The sulphur of the pyrite in coal is also an important raw material at gas-works, where the sulphur is caught by iron oxide, which is afterward sent to the acid plant. Much sulphur is also recovered from alkali waste and thus used over again. In the old days the acid was produced by the dissociation of green vitriol, or ferrous sulphate, a source that explains the origin of the name 'oil of vitriol.'

In considering the mode of manufacture of sulphuric acid, it is well to recapitulate the information in the text-books relating to the various compounds. Sulphur burns to sulphur dioxide, otherwise sulphurous acid, SO_2, which under circumstances depending on its proximity to certain other substances takes to itself another atom of oxygen to form the trioxide, anhydrous sulphuric acid, SO_3. The trioxide is solid in cool air and liquid up to 115° F. A characteristic difference between the dioxide and trioxide is that the dioxide is sparingly soluble in water, whereas the trioxide has a violent affinity for it. Thus the sulphurous part of smelter smoke, being gaseous, is comparatively innocuous, while the small proportion of anhydrous sulphuric acid accompanying it causes serious havoc in the neighbourhood, through combining with the first moisture it meets and being precipitated as sulphuric acid, H_2SO_4. As already mentioned, sulphuric acid was formerly made by the dissociation of ferrous sulphate, which on heating yields SO_3. This anhydrous acid was lead into water to make H_2SO_4. There is also another compound of anhydrous acid and water, containing two molecules of acid to one of water, $H_2S_2O_7$, known as fuming or Nordhausen sulphuric acid. It is formed by passing SO_3 into H_2SO_4. In Germany, the old term 'oleum vitrioli' is employed to denote this fuming acid, and in explosive circles in this country the term is colloquially abbreviated to 'oleum.' For many years the fuming acid was made in England and in Hungary by the ferrous sulphate process, but as it was expensive and the demand for strong acid was greatly increased on the establishment of the aniline dye and nitro-explosive industries, other sources had to be sought. Long before that time the ferrous-sulphate process had been abandoned for the manufacture of less strong acid, in favour of the 'chamber' process, according to which nitrous fumes are employed for continuously conveying atoms of oxygen from the air to the sulphurous acid coming from the burning of sulphur or pyrite. This process requires the presence of steam, otherwise an entirely different reaction-product is formed, and the use of steam results in a weak acid being produced, containing a large proportion of water. The concentration of this acid is effected by means of heat in specially designed stills, platinum or glass being the usual containing material, and also by passing hot gases against the flow of the weak acid down from one earthenware dish to another or over mineral substances such as lava. But the concentration cannot be carried far enough for some purposes. When the acid is to be employed in reactions liberating water, or in conjunction with substances containing water, it is desirable to employ fuming acid, and when reviving weak acid during the course of operations it is sometimes more advantageous to add fuming acid instead of re-concentrating by heat. The demand for acid stronger than that obtainable by the chamber process, in larger quantities and at a lower price than the ferrous-sulphate process could supply, became so great that English and German chemists in the seventies once more turned their attention to the 'contact' process. According to this process, the atom of oxygen is transferred from the air to sulphurous acid by bringing the mixture into contact with a solid catalytic agent, which effects the junction without undergoing any physical and chemical change itself. Platinum possesses this power to a remarkable degree, and very small amounts of it can be employed to produce large quantities of acid. The reaction is similar to that of the well known experiment in the chemical class-room, where a platinum sheet on being held over a gas jet becomes red hot and ignites the gas. In this case the platinum acts as a catalytic agent for bringing hydrogen and oxygen into combination. This power of platinum was first observed by Sir Humphrey Davy a hundred years ago. In 1831, Peregrine Phillips, of Bristol, applied platinum for causing the union of sulphurous acid and oxygen of the atmosphere, for the purpose of manufacturing sulphuric acid, and to him is due therefore the title of 'father of the contact process.' In 1875 the method was revived simultaneously and independently in England and Germany, by W. S. Squire and Clemens Winkler respectively, and after twenty years of laborious study and experiment, practicable methods have been evolved. Details of English practice have never been published, and it is not generally known that the process is widely used here. In Germany, the Badische Anilin und Soda Fabrik has used the process in which platinum black deposited from solution on porous mineral such as asbestos is employed as the catalytic agent. The Grillo Zinc Company has adopted Schroeder's modification, using a soluble salt such as magnesium sulphate as the material on which the finely divided platinum is deposited, the advantage of the soluble structure being that the platinum may be more easily recovered when the surfaces have been fouled by impurities in the gases and the power of the platinum thereby reduced. For the successful operation of the contact process, all extraneous substances should be preliminarily removed, and care has to be particularly exercised that arsenic is not present, for in the words of the contact chemist, "arsenic is a poison," as it is everywhere else. Recent investigations have shown that other materials have a catalytic action, by themselves or in conjunction with platinum, and the expense of the installation is thereby reduced owing to smaller amounts of this expensive metal being required. The magnesium sulphate used in the Schroeder-Grillo process has catalytic power, and oxides of iron and chromium have also been used for this purpose. The actual working details of these contact processes are so far removed from the immediate interests of our readers that we need not enlarge on them here. We may suitably end this article by expressing the hope that sulphuric acid itself is not used and never will be used in warfare.

THE FAR EAST RAND

By E. T. MELLOR.

As a result of studies made for the Geological Survey it is found possible to correlate the reefs found in the Far East Rand. The Van Ryn, Brakpan, Springs, Daggafontein, and Nigel are all found to be one reef, the 'Main Reef Leader' of the Central Rand. There are barren and rich patches disposed in areas with the major axis northwest-southeast and this is held to be consistent with the delta theory of formation of the Rand deposits. Drilling along east-west lines is recommended in development, and the Far East Rand is regarded as constituting a reserve likely to maintain the Rand for many years in its position as the premier goldfield of the world. This article follows the one by the same author appearing in the Magazine for November.

*THE extensive and comparatively shallow synclinal basin of the Far East Rand, the existence of which was demonstrated long ago by the work of F. H. Hatch and others, still remains largely undeveloped. To it, many look with a confidence which is largely justified by what we already definitely know of the area, for the maintenance for a long time to come of the dominant position of the world's gold production held by the Witwatersrand. One sometimes hears references to the "decline of the Rand" as if that were an imminent event, but in view of the possibilities of such an area as the Far East Rand, of the known resources of the Central and nearer East Rand, and of past experience as to the way in which, owing to the existence of bodies of ore of which no account had been taken in previous estimates, apparently moribund mines continue to flourish for years, thus to anticipate the decline of the Rand appears much as if one should speak of the decline of a man in the thirties.

Owing to the extent to which the Far Eastern Rand remains covered by later formations like the dolomite and the rocks of the Karroo system, which have been much more completely denuded from the central and western portions of the district, outcrops of the Witwatersrand system are comparatively limited in extent, and the surface geology correspondingly monotonous and uninteresting over considerable areas. The Karroo rocks, which lie practically horizontally and consist mainly of coal measures and the remnants of a dolerite sheet, form a comparatively thin covering over a large portion of the area.

The almost continuous outcrops of the Witwatersrand system which characterize the Western, Central, and nearer Eastern portions of the Rand do not disappear suddenly under the cover of dolomite and Karroo rocks of the far East. They are lost to view gradually under the broken fringe of these later slightly inclined or horizontal formations, and frequently reappear in a number of small and widely scattered inliers. The limited and scattered nature of these small inliers, which frequently occupy the floors of pans or are exposed for short distances along some of the shallow 'vleis,' renders the identification of the rocks exposed a matter of some difficulty, which can only be satisfactorily dealt with after an intimate acquaintance has been made with the more continuous exposures of the nearer portions of the Rand.

The extensive exposures of the Central and nearer East Rand, can, in their lower portions at least, be followed without serious interruption to the north of the township of Benoni, almost to the eastern boundary of the farm Kleinfontein. In this neighbourhood and to the east of it the Lower Witwatersrand rocks are extremely broken.

A fairly complete section of the 'Government Reef series' is to be seen along the valley of the spruit which runs northwestward from Benoni township. The Government Reef, though thin, is characteristically developed and the Coronation horizon also recognizable. Southwest of these Benoni exposures, the quartzites of the Government Reef series are exposed in two inliers, one occupying the floor of the large pan in the southwestern angle of Kleinfontein, and one crossed by the Main Reef road and by the southern boundary of the adjacent farm of Klipfontein. These two inliers are particularly interesting because they show clearly that the outcrop of the Government Reef quartzites also tends to follow a very similar bend to that which carries the horizon of the Main Reef zone southward toward the Apex mines in this locality. It is remarkable, but perhaps very natural, that such significant outcrops as those of the Government Reef quartzites just referred to appear to be persistently ignored by the supporters of a view that the sub-outcrop joining the Cason and Blue Sky (properties belonging to the East Rand Proprietary

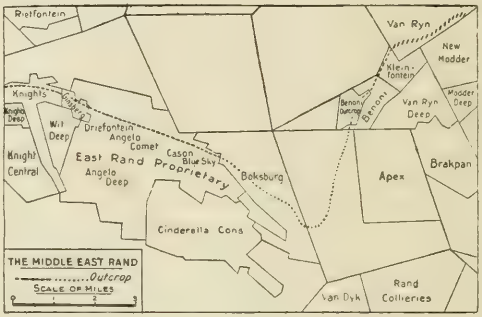
*From advance proofs of a paper read before the Geological Society of South Africa. See *The Mining Magazine*, November, 1915.

Mines, the situation being indicated on the detached map on this page) to the Van Ryn mines passes almost directly across the intervening space instead of following the curve by the Apex usually and correctly ascribed to it. The idea just referred to was responsible for much fruitless boring and prospecting in former years, which has continued at intervals to the present day. In a similar way, when it has been sought to connect the reefs of the Rietfontein mines with those of the Van Ryn, the presence of extensive outcrops of thick series of quartzites which render such a connection almost inconceivable has been persistently lost sight of.

Eastward from Boksburg the practically continuous outcrops of the nearer East Rand cease to be available. The country is extensively covered by later formations and the Upper Witwatersrand rocks are only occasionally seen in widely separated inliers. Some of these are of considerable interest for the evidence they give of the general trend of the Witwatersrand system beneath the later rocks.

Thus the Elsburg Reefs and the line of junction of the Klipriversberg amygdaloid with the top of the Witwatersrand system are exposed in a small inlier on the western portion of the farm Witpoort, to the south of the Van Dyk mine. The continuation of the same line of junction is also seen on a more extensive scale about two miles farther east. A small inlier to the south of the Apex mines contains outcrops of beds probably not far from the horizon of the Bird Reefs, including a small exposure of amygdaloidal diabase perhaps assignable to the 'Bird Reef marker.'

The various outcrops just mentioned are interesting because of the various interpretations that have been put upon them in connection with prospecting and similar operations in this area. In a recent paper* reference has been made to the fact that the disappearance of the outcrop of the Main Reef zone under a covering of later rocks in the neighbourhood of the Blue Sky mine, and the sharp bend in the continuation of the sub-outcrop in the neighbourhood of the Apex, the existence of which has been so thoroughly demonstrated by numerous boreholes, have rendered this locality the starting point for the most diverse suggestions as to the further course of the sub-outcrop of the Main Reef zone and other horizons. Some of these interpretations of the local geology necessitate a line of outcrop for the Main Reef zone considerably south of its generally accepted position, and such a line is sometimes obtained by joining up isolated outcrops such as those found in the small inliers above referred to, or such incomplete exposures as lie on the fringe of the younger rocks, as, for example, to the southeast of Boksburg township. Individual beds of conglomerate may



be found among the Kimberley and Elsburg Reefs, especially in the Eastern Rand, which afford specimens having a close resemblance to the conglomerates of the Main Reef zone, and a line is sometimes drawn through outcrops of such reefs belonging to entirely different horizons and adopted as indicating the outcrop of the Main Reef. In such a fashion, outcrops of the Main Reef zone on the East Rand mines may be joined up with outcrops of the Kimberley Reefs on Leeuwpoort to the southeast of Boksburg, and the line thus begun prolonged southeastward to join the outcrops of the Elsburg Reefs to the south of the Van Dyk mines. Such supposed lines of strike are such as one might make on a hasty traverse with observations depending mainly on the eye alone. When the outcrops, however, are properly plotted by means affording reasonable accuracy and their relationships to neighbouring exposures duly represented, the contradiction between the supposed line of strike and the true one is at once apparent to any unprejudiced observer.

To the east and southeast of the inliers above mentioned, outcrops of the Witwatersrand system are practically absent until the neighbourhood of the Nigel mine is approached. The greater portion of the Far East Rand would be a very uninteresting tract of country to the geologist whose observations were restricted to the surface. Owing, however, to the large number of boreholes put down in the district, and the recent considerable extensions of mining operations, our knowledge of the deeper geology of the Far

* 'The Upper Witwatersrand System,' *Trans.* Geol. Soc. S.A., vol. xviii., 1915.

East Rand is very considerable.* In connection with my survey of the Far East Rand, I have examined the records of practically all the principal boreholes in that area. Anyone undertaking a similar examination will find it in some respects a very tedious and unsatisfactory task. Many of the boreholes were put down in what are regarded as the earlier days of the field, the main object being the intersection and testing of the 'reef.' Consequently the records frequently take little account of many points which are of great value in the interpretation of the sections given by the holes. In some cases the records are the work of the drillman, whose determinations and descriptions of the rocks intersected are not always of the best. In some cases it is only by comparison of the records with those of neighbouring holes that the meaning of terms used in descriptions can be made out, and in the majority of the holes the want of a survey of the hole itself very materially affects the value of the section, especially in deeper examples.

FAR EAST RAND AND HEIDELBERG DISTRICT

Owing to the removal by denudation of the greater portion of the Kimberley-Elsburg series over the area in question, the beds intersected rarely extend far above the Kimberley shales, and are chiefly interesting in connection with the Main-Bird series, the principal members of which, described already in connection with the Upper Witwatersrand system, are represented more or less throughout the Far East Rand. In connection with the sections at present under consideration, the following features may be briefly noted. The consistency of the results given by the various boreholes and shafts distributed over a considerable area is very satisfactory, and such variations as exist occur in a regular manner, which should allow of their application to other sections in the same neighbourhood. The thinning of individual members corresponding to a similar thinning of the whole series is most marked in sections taken in a northwest to southeast direction. It is less so in the section taken from north to south, and scarcely apparent in the section taken in a northeast to southwest direction. The results obtained in various other sections constructed on similar lines indicate that these conditions are of more or less general application, and appear to me to point, like many other observations made both in the Eastern area and the nearer portions of the Rand, to the source of the sediments concerned having been situated to the northwest of the present Rand and to their having been distributed by

* For important papers dealing with the results obtained from certain boreholes in the Far East Rand see 'The Extension of the Witwatersrand Beds Eastwards,' etc., F. H. Hatch, trans. Geol. Soc. S.A., vol. vii., pp. 57-69: and 'New Facts bearing on the Extension of the Main Reef Eastward,' J. McL. Henderson, trans. Geol. Soc. S.A., vol. viii., 1905, pp. 151-157.

a definite southeasterly current. In this connection the evidence afforded by the shape and mode of distribution of the patches of conglomerate shown by the principal reef of the Far East Rand has already been referred to, and their probable origin under conditions allied to those of extensive deltas discussed.*

To turn now to individual members of the Upper Witwatersrand system: the unquestioned identity of the Van Ryn Reef (Main Reef Leader) with that of Brakpan, and the evidence afforded by a chain of boreholes connecting the reef at Brakpan with that at Springs and Daggafontein, and these again with the Nigel Reef, places the identity of the latter with the Van Ryn Reef beyond reasonable question. Such differences as are found in the reef at the two localities are consistent with all the intermediate evidence, and are not greater than those found in continuous bodies of reef exposed within the limits of a single mine. I have recently had opportunities of examining much valuable evidence from numerous boreholes and shaft sections and from surface prospecting in the neighbourhood of the Nigel mine. The agreement between the section there and the Daggafontein section is remarkably close, and there can be no doubt about the correlation of the two, supported as it is by numerous intermediate boreholes.

The marked arrangement of the whole of the reef in the Nigel mine in the well defined patches described in the paper on the Upper Witwatersrand system and the corresponding mode of distribution of special portions of the reef in the Brakpan mines and at New Kleinfontein and Van Ryn, is not limited to these mines, which have been quoted as examples. Similar conditions are found to prevail in many other instances, and borehole results show that they are also present in many localities from which no direct mining evidence is available. It seems probable therefore that such conditions will be found to obtain in many parts of the Far East Rand, and the evidence at present available points to such conditions being much more marked as we proceed farther in a southeasterly direction from the northern outcrops, and to be most marked in the neighbourhood of the Nigel. Consideration of the distribution of the conglomerate patches in the Nigel mine shows how easy it would be in such an area to put down numerous boreholes without intersecting any portions of the reef, which nevertheless has been the basis of profitable mining for a period of nearly thirty years. This disposition of the conglomerate, or special portions of it, in well defined patches over a large portion of the Far East Rand will probably afford opportunities for both optimists and pessimists to indulge in speculations agreeable to their own particular bent of mind. The former will be inclined to enlarge upon the desirable patches, and the latter to exaggerate the interspaces, and to deplore the fact that the whole area is not equally favoured by nature. A saner view, however, will probably be that of the practical mining man, who will be thankful if he finds that, instead of having extensive areas which keep him long in doubt as to whether they are workable or not, he has to deal with material which, over definite areas, is quite decided in character, in which, in fact, the processes of sorting and concentration frequently necessary after the material has been mined, have already been partly effected by nature. And in this connection we must not overlook the fact that considerable areas of unprofitable ground are far from being unknown even on the most favoured portions of the Rand. When, however, three workable reefs are present in a mine, as in the more central portions of the Rand, the probable coincidence of the better areas in one reef with the unprofitable ones in others renders the presence of the latter much less conspicuous in stope plans and other records connected with such mines than is the case with a single reef.

In the Far East Rand, in borehole sections that intersect the Main-Bird series, reefs of the Bird group appear to be always sufficiently in evidence to figure in the records. They occur over a thickness of from about 200 ft. in the north to about 80 or 100 ft. in the southern portion of the area, and are very generally grouped more conspicuously at the top and bottom of the zone that they cover, the lower band being perhaps the stronger of the two. This is frequently named 'Modderfontein series' in borehole records, but it lies far above the horizon which would correspond to that of the Modderfontein or Livingstone group of reefs in the better known portions of the Rand, including Modderfontein. The latter group is also represented in the far southeastern Rand, but appears to be as a rule feebly developed, consisting of a few small bands of grits or very small-pebbled reef. Occasionally, however, borehole records show a strong development of more pronounced conglomerate bands at this horizon, so that the group must be very variable in character,

* *The Mining Magazine*, November, 1915, p. 258.

and is consequently of little value for correlation purposes.

One of the most important 'markers' over the whole Eastern Rand is undoubtedly the amygdaloid sheet which lies close above the Bird Reefs, and might well be called the Bird amygdaloid. In the extreme east and south-east the amygdaloid frequently lies directly upon the uppermost conglomerates of the Bird group; while coming toward the Central Rand it is separated from them by a constantly increasing thickness of quartzite. In the neighbourhood of Daggafontein mine the thickness of the amygdaloid attains 250 ft., diminishing toward the north and west. Borehole sections frequently show a much greater thickness of igneous rock about the horizon of the amygdaloid than the normal for that sheet. In some cases this appears to be probably due to a subsequent intrusive sheet having followed the amygdaloid horizon, but in others it is most probably to be accounted for by a dike having been passed through in the immediate neighbourhood of the amygdaloid. The fact that the amygdaloid itself may be devoid of amygdules over a large portion of its thickness, and that the cores of the holes are in many cases no longer accessible, renders an exact explanation of such cases impossible. Faulting of a simple kind frequently met with in the area may also obviously bring about an apparently abnormal thickness of amygdaloid in a borehole section, as also it may equally easily eliminate the amygdaloid from any particular hole altogether. The small importance attached to the occurrence of an amygdaloid at the time the boring was done probably accounts for it not being recognized in some of the earlier records, although a rock resembling the amygdaloid in appearance is mentioned. This appears to be the case in a borehole on the Nigel Deep, in which no amygdaloid appears between the horizon of the Kimberley shales and the shales below the Nigel Reef, at least in the record. Numerous other boreholes, however, in the same locality show a normal occurrence of amydgaloid at the usual horizon, and the rock has been intersected in many shafts in the Sub-Nigel mine, and shows a thickness for this locality of about 210 ft. Since sheets of amygdaloid occur at several horizons, the mere intersection of a rock of this type is of little value in itself as a determining horizon. The usual threefold combination of the amygdaloid just referred to with a well marked group of conglomerates like the Bird Reefs, and of these again with a considerable thickness of argillaceous beds like the Kimberley shales, affords, however, an extremely valuable means of correlation in borehole sections in the basin of the Far East Rand.

The Kimberley shales are well developed throughout the Eastern and far Eastern Rand, showing much less diminution in thickness as compared with the central area than is the case with the coarser members of the series. They form one of the most important means of correlating borehole sections. Probably a more correct idea would be obtained of the structure of the eastern basin by constructing a contoured plan of the Kimberley shales throughout that area than by confining such contouring to the horizon of the 'reef,' as is very frequently done. In many instances by the time a borehole has penetrated the Kimberley shales its inclination from the vertical has become so considerable that in the absence of a really reliable survey, which is never very easily obtained, and in many instances does not exist at all, very considerable difficulties may arise in the estimation of the true depth of the hole, a point which will be again referred to below.

The Kimberley reefs have been intersected in many boreholes on the Far East Rand, where, although perhaps not so strongly developed as in the centre and west, especially as regards the thickness of individual reefs and the maximum size of the pebbles, they are well represented. As already pointed out, the gradual thinning of the quartzites, which on the Central Rand are almost invariably present between the Kimberley reefs and the shales below, results in the lowest pebble-band coming to lie directly upon the shales. Such a reef may therefore have a shale foot-wall, and, as it may also give encouraging assays, it invites identification with the Van Ryn or Nigel Reef, that is, with the Main Reef Leader horizon. In most instances the number, size, and character of the reefs found associated with it would be at once sufficient to suggest its membership in the Kimberley group, since nowhere are so many reefs found above the Main Reef Leader as are usually met with in such cases. Toward the extreme easterly margin of the Far East Rand basin, however, where a borehole may possibly intersect only the lowest portion of the Kimberley group of reefs, it is not always possible to apply such means of identification. In numerous instances in the eastern basin notable assay values have been found in well developed reefs at a little distance above the top of the Kimberley shales. One of the best known examples which frequently presents a very promising appearance at the outcrops is the well-known 'Joel Reef,' which can be followed at the surface for considerable distances in the neighbourhood of the Sub-Nigel mine.* Its position with regard to the Kimberley shales is there quite clearly shown, leaving no room for doubt as to its stratigraphical position.

The Elsburg reefs have been more or less denuded from the greater part of the eastern basin, but a complete section, together with the over-lying amygdaloid, is still represented in a portion of the area lying above the axis of the main syncline, as, for example, in the neighbourhood of the farm Vlakfontein 26. Compared with the Central Rand the Elsburg Reefs in this district are much less conspicuously developed, and the average and maximum size of the pebbles is much smaller, so that the reefs conform more in this respect to those of the Main Reef zone. Some of the most conspicuous reefs occur not far below the junction of the top of the series with the amygdaloid, and are very abundant in the first five hundred, and particularly the first hundred, feet below that horizon. Pebbly bands are, however, of frequent occurrence throughout the quartzites between the main groups of Elsburg and Kimberley reefs as in other parts of the Rand, and the similarity between the Kimberley and Elsburg portions of the series is perhaps even greater than in the central area.

An examination of the borehole records on the Far East Rand shows that in numerous instances considerable doubt was felt at the time the borehole was put down as to the identification of the particular horizons passed through, and the boring was frequently carried considerably beyond the horizon of the reef which formed the objective of the hole. The circumstances which appear to have most commonly led to doubt as to the particular horizon reached in various holes have been the frequent absence of anything like a well defined reef at the horizon of the Main Reef zone, and the presence in many instances of a well developed reef, occasionally yielding encouraging assays either immediately upon the Kimberley shales or at no great distance above them. In the former case reluctance to accept an unfavourable result frequently led to a continuance of the boring far beyond the usual horizon; in the latter the promising appearance of the reef found and its association with a shale foot-wall were frequently the grounds of its acceptance as the reef sought for, from which in other respects it offered many points of difference. Where, however, a sufficient thickness of beds has been intersected before the Kimberley shales are reached, the number and size of the reefs met with above the shales should leave little doubt of their belonging to the Kimberley group. It is extremely rare to find even a few inches of quartzite between the true reef horizon on the Eastern Rand and the slate foot-wall, and the occurrence of any large numbers of well marked pebble bands within a short distance above that horizon is also of very rare occurrence. In a covered area like the Far East Rand we are dependent for our estimates of the local thicknesses of various portions of the Witwatersrand system largely on boreholes, which do not always show very consistent results. As the number of boreholes increases, however, and we are able to select those which are obviously most free from the discrepancies resulting from the presence of faults and dikes affecting the formations passed through or from considerable and uncertain deflection of the hole, it is possible to form more definite ideas as to the normal thicknesses which are characteristic of any particular locality, and this is the easier when, as in the case of the Far East Rand, such thicknesses do not appear to be liable to any rapid variation. When sufficient evidence has been accumulated to render such estimates of thicknesses fairly reliable, it seems justifiable to apply the data so attained as criteria of the results of any particular hole. The application of this method in the Far East Rand appears to indicate that in some cases the commonly accepted deductions drawn from the borehole results may be open to revision. One well known hole to which such considerations apply is the Grootvlei-Daggafontein joint borehole. This hole is regarded as one of the most important on the Far East Rand, and an inspection of the contoured plans of the reef horizon published with the papers of Hatch and Henderson, as well as the similar plans which have been constructed by other engineers shows that the data furnished by this hole have had a considerable influence in the laying out of the contours, the hole being usually shown as a centre, around which the deepest contours have been drawn. The true depth of the hole is not known, as it was found impossible to survey the lower portion, and the depth of the reef given for this hole, 4880 ft., is based upon the assumption that the inclination from the vertical in the lower portion is only 30°. The thickness given for the beds between the Bird Reef amygdaloid

* See S. J. Truscott, *The Witwatersrand Goldfields*, p. 55.

and the foot-wall slates measured along the course of the hole is 916 ft. On the other hand, the true thickness would appear from the data derived from other holes and shafts in that neighbourhood to be approximately 600 ft. Assuming, as is most probable, the beds to be but slightly inclined, and that no serious faulting occurs, the difference between these figures would indicate that the borehole traversed the beds in question at an angle of about 50° to the vertical, an inclination which seems probable enough from the depth of the hole and the surveys given of its upper portions. This deduction appears to confirm the opinion expressed in the reports on this hole that it had a greater inclination than that upon which the estimate of 4880 ft. for the depth of the reef at this point was based. The fact that a less inclination involves the supposition that the hole after diverging considerably from the vertical again approached more nearly to it, appears further to confirm the view expressed above, since the return of a borehole toward the vertical is extremely unlikely, judging from a large number of surveys of which we have records.

It seems probable, therefore, that the horizon of the Main Reef zone in the Far East Rand may lie at a much more accessible depth in some localities, including the borehole referred to, than that usually attributed to it. On the other hand, at other points, the depth may be greater than is sometimes assumed to be the case. Thus the disposition of the amygdaloid on Vlakfontein 26 and the known position and dips of the top of the Elsburg beds to the north and south indicate that the main axis of the Far East Rand syncline must pass very nearly across the middle of that farm, and that the depth of the Main Reef zone on the axis of the syncline about the common boundary of Vlakfontein and Grootfontein probably exceeds 6000 ft., diminishing both to the north and south and increasing as the axis is followed in a westerly direction. The depth which has been attributed to the slate foot-wall of the Main Reef horizon in the locality referred to more probably represents that of the top of the Kimberley shales.

A further point of interest in the far eastern area is the position of the sub-outcrop of the Main Reef zone along the eastern margin of the basin. It has been approximately indicated by Hatch, and in the extreme southeast more completely by Henderson, in the papers referred to.

The records of many of the holes in this locality which were put down in what were the early days of borehole prospecting on the Rand are not very promising material for certain correlation. The horizon identified by Hatch with that of the 'Main Reef' as indicated by the depth given in connection with the boreholes on Vlakfontein 21 are, I think, more reasonably to be referred to the top of the Kimberley shales. This interpretation favours the more liberal estimate of the extent of the reef horizon in this neighbourhood given by Henderson. It is claimed that certain boreholes near the southwestern corner of the neighbouring farm Vischkuil intersected the Nigel Reef horizon; the available records are, however, still less definite than some of those in connection with Vlakfontein. Projections of the reef horizon based upon the dips and other data available from the neighbourhood, including those from the workings in Daggafontein, appear to indicate the extension of the horizon of the Main Reef zone as far as the southwest corner of Vischkuil, but the extremely low dip shown by the beds in this locality render such projections of doubtful value, a very small difference in the dip having a very great effect on the position of the sub-outcrop. It is, however, not clear upon what evidence Henderson's contours show an inward curve in this locality. The results previously obtained do not appear to have favoured more extensive prospecting in this locality; the recent more favourable experiences on Daggafontein may, however, lead to a more complete exploration.

If, as seems probable, the mode of distribution of the conglomerate described in connection with the Nigel and other mines should prevail over a large portion of the Far East Rand, it is obvious that the disposition of a series of boreholes in an approximately east and west line is more likely to give definite results than any other arrangement. The finding of such isolated patches of conglomerate as exist in the Nigel area must in the first instance be largely a matter of chance, and their continuity in any direction can only be proved by a series of holes placed comparatively closely together.

A question which naturally arises from the consideration of the geological features of the Far East Rand is to what extent they tend to throw light on the problem of the probable extension of the conglomerates of the Main Reef zone to the south and southeast of the Witwatersrand area. We have seen that there appears to be a very distinct and consistent falling off in the development of the conglomerates in the direction indicated, which, on the grounds stated in this and in my recent paper on the Upper Witwatersrand system, is probably distinctly attributable to conditions connected with the source and mode of deposition of the conglomerates. The less vigorous development as we proceed toward the southeast is common to the whole of the Witwatersrand system. Consistent and scientific attempts to find the horizon of the Main Reef zone, largely based, however, upon data furnished by Central Rand sections, have been made far to the south of the Witwatersrand, unfortunately so far without success.

SAMPLING AND ESTIMATING MESSINA ORE RESERVES.

The recent re-sampling of the Messina Copper Mine in the Northern Transvaal by Mr. A. F. Kuehn presented certain interesting problems which warrant a description of the methods employed. While Mr. Kuehn will be the last to claim that the methods adopted were novel, though the problem involved unusual difficulties, their description undoubtedly has educational value, as the work illustrates the actual details necessary when an engineer has to value a working mine where he, for any reasons, depends only on his own sampling. Mr. Kuehn's sampling was done in May and June last for the Messina (Transvaal) Development Co., Ltd. The end in view was to make an estimate sufficiently accurate for practical purposes, in any reasonable period, and with an untried staff of two young engineers, in addition to the fullest co-operation of the mine staff; and to have sufficient checks to be assured as to the accuracy of the methods and the results.

At the Messina mine, the ore shoots, irregular as to shape and width, are erratically distributed in fissures in a gneissic granite. Two of them have been proved up to 1000 ft. in depth. One lode from various small shoots has thus far yielded about 1 ton per 8 sq. ft. of wall; another lode, from several shoots, yielded about 1 ton per 4 sq. ft. of wall; while the two largest or 'Bonanza' shoots vary in width up to 40 ft. The average grade of ore mined is about 6·2% copper, the various stopes yielding ore assaying from 3% to over 10%. The ore consists of varying proportions of generally massive glance, bornite, and chalcopyrite. The ore occurs in streaks paralleling the strike, in irregular patches, and in some cases as a cementing material from 2 to 15 in. thick in a breccia consisting of pieces about 2 ft. in size. The gangue is generally a barren or slightly altered white quartz gneissic granite with some accessory minerals. The broken ore therefore lends itself both to some underground and to considerable surface hand sorting, which yields a practically barren product, a small shipping product, and a milling product. Flat, practically horizontal patches and also nearly vertical ones, of massive copper sulphide, generally of small extent, are sometimes found in the walls connected to the shoots.

The development consisted of various drifts, cross-cuts, rises, and winzes on 10 levels at 100 ft. intervals. The ore extracted to July 1, 1915, plus the ore reserves at that date, is shown in the tabulation below. Account is taken of six principal shoots in the two main converging lodes and two branches. The totals to the fourth and to the tenth levels are shown separately, as one lode and one shoot are not developed below the fourth level.

	0-4 Level	0-10 Level
Tons ore per 100 ft. of depth...	47,000	39,400
Bonanza shoots, % of total......	39	65·1
N.L.W. ,, ,, ...	12	6·6
N.L.E. ,, ,, ...	28	13·5
Mid. L. ,, ,, ...	17	8·4
S.L. ,, ,, ...	4	2·0
Undistributed ,, ...	–	4·2
	100	100

The company's stope-book records showed areas of ore mined at different stope horizons, and assay plans disclosed the value of the ore found in drifts and cross-cuts on levels and in winzes and rises, but complete records of assay-value of ore mined from different stope sill floors were lacking. The stopes are filled with waste and it was impracticable to sample ore under them. It was found that the records of areas of ore stoped erred on the low rather than the high side, that assay plan records of ore in rises and winzes could be confirmed, and that, although the drifts and cross-cuts in ore shoots stoped out on levels showed insufficient assays on which to base a valuation, these records tended to confirm the statement that the areas were pay ore areas. This was further in part confirmed by the total ore extracted. It was, therefore, decided to classify as 'practically proved' ore, blocks where there was available a stope-book record of sill floor area or top area, and a stope back or other measurable bottom area which would be sampled. Rises proved the continuity of ore between, but assay records in them were not used in calculations. It was recognized that the assay-value assigned to any one block of a shoot was liable to error, but it was considered that the average assay of all the blocks of a shoot would be, for all practical purposes, correct. Subsequent operations confirmed this. The two Bonanza shoots presented six faces each for complete sampling, and a smaller one three faces, exclusive of rises and winzes. The ' practically proved ' ore of three shoots was allocated to 16 principal, and three minor blocks, between levels, averaging 56 ft. in height (limits 25 ft. and 93 ft.), averaging 140 ft. long (limits 48 and 281) and averaging 1536 sq. ft. in horizontal sectional area (limits 340 and 8000 sq. ft.)

Ore was also being mined from places that showed one face only. Such occurrences were classified as ' Prospective ore in the developed area.' They were, incidentally, largely faces of low-grade ore, that it would not pay to mine at low copper prices.

After the preliminary examination it was decided that the smaller rich shoots on sill floors and the low-grade faces could be quickly and accurately sampled by cutting grooves at 5 ft. intervals, averaging about 7 lb. of cuttings per foot minimum, whereas in the case of the Bonanza shoots, which contained about 90% of the ore reserves, it was necessary if possible to take samples from complete strips from 5 to 7 ft. thick, broken from the backs. It was, of course, found necessary to combine the two methods of sampling.

The various stope-boxes or chutes were numbered, and to each one was allocated a metal hook or ring containing 9 good sized rectangular marked tags to one which was round and similarly marked. A tag was taken from the hook and placed on each car as drawn. Each tenth car thus contained a round tag, and it was diverted and hoisted to the surface. Each four consecutive cars of sample constituted one sample for assay. The ore was rough cobbed to 2 in. size, cut down to about one car, and the resultant crushed through rolls, etc., and pulps in triplicate taken for assay. One assistant was kept fully conversant with stoping operations, and constantly went from one stope box to another to replenish the hooks with tags, and to tally cars despatched, as well as see to the transit of sample cars to a shaft. He was assisted by Kaffir boys, who kept watch on the various levels to prevent changing of tags during congestion of traffic. His tally was checked against the mine tally for hoisted ore, and against the sample crushing crew's tally of samples received. It was thus possible to ascertain the degree of accuracy with which the tenth cars were being taken from the ore broken in the different stopes, and further to discard at the surface cars from a stope where the material shovelled in the box was considered to be irrelevant to the sample as a result of caving or other accidents. Stope backs were carefully surveyed at the beginning of the sampling campaign, and the progress was constantly watched by another assistant and Mr. Kuehn, and noted so that samples up to different dates could be approximately allocated. In a few places resort was made to groove sampling where ore readily lent itself to this method, or when it was found that miners had not broken deeply enough. This was necessitated largely by the decision not to interfere with the company's mining and filling operations if possible.

Car samples were taken from every stope, although the results of all car samples were not used to calculate the value of ore reserves. The calculated average value of ore extracted for June from every tenth out of 10,426 cars drawn and hoisted was found to be about 11% higher than the value ascertained by the automatic mill sampler, and therefore the factor of 90% was applied to faces valued from car samples. The cutting down of car samples was constantly checked at the 2 in. and finer stages. Duplicate pulps were always, and sometimes triplicate pulps were assayed. In all 1075 cars of samples produced 268 samples for assay. At the end, in the case of less than four sample cars remaining, the assay result from this number of cars was algebraically averaged with the others.

No difficulty was encountered in groove sampling the low-grade ore. It was however necessary to sample some small shoot backs by this method where the ore consisted of scattered patches of from one square foot to about 20 sq. ft. of bornite in a largely barren gangue. In such cases the value of the area of the massive copper mineral was averaged with the necessary area of barren rock, but no account was taken of the difference in specific gravities, as such a procedure was considered an unnecessary refinement. It was found practicable to check by stoping operations the area allowed by groove sampling. In all cases the maximum length of sample was 5 ft., and all ores of distinct appearance were sampled separately.

MINERALIZATION IN MALAYA. II.

By WILLIAM R. JONES.

In this, the second and concluding portion of the article begun by Mr. Jones in the October number of the Magazine, he points out the widespread presence of cassiterite and associated minerals in the various rocks along the contact with the granite. He describes a number of deposits of tin ore *in situ* now being worked, and discusses various theories of origin, favouring strongly the pneumatolytic hypothesis. Mr. Jones feels that the large opportunities in Malay mining are now to be found in development of the lodes, and that properly organized effort will readily overcome the pumping difficulties. The illustrations have been prepared from photographs in his private collection.

THE veins of granite-pegmatite, granite-aplite, quartz, and quartz-tourmaline which are so common over extensive areas of the granite country of Kinta district, Ulu Selangor, parts of Negri Sembilan, and elsewhere in Malaya, and which frequently carry cassiterite, are not confined to the granite but are also intrusive into the schists (chiefly mica-schists and tourmaline-schists), the phyllites, and into the limestone with which the granite is in contact. In some places, notably at Serendah in Ulu Selangor, and in various parts of Kinta, these veins have been found continuous from the granite into the mica and tourmaline schists but in only two cases, both in the east of the Kinta district, have I been fortunate enough to see a granitic intrusion laterally continuous from granite to limestone.

Veins and Impregnations in Schists and Phyllites.

With certain exceptions, which will be noticed later, the veins of cassiterite-bearing rocks, mostly granite-pegmatite and quartz, are found in the schists near the granite junction and this intense mineralization at, and a little away from, the periphery of the granite mass is a fact of much scientific interest and of great economic importance. It is remarkably well illustrated in the part of Ulu Selangor I have recently mapped geologically. There it has been proved that, with the exception of a stretch of about eight miles between Kuala Kubu and Ulu Yam, where mining is not allowed and hence where little time could be afforded for economic geological work, tin-ore has been found in the schists at, or near, its junction with the granite of the Main Range from near Tanjong Malim, on the northern boundary of Ulu Selangor, to Ampang, Kuala Lumpur, near its southern boundary. Even in the eight-mile stretch mentioned above a little tin-ore was found *in situ* at the foot of Bukit Penyanyar, Ulu Batang Kali, but examination of the streams in the neighbourhood showed the presence of only a small amount. Here then we have a fact of the greatest geological and economic importance, namely, that practically all along the junction of the granite and schist from Tajong Malim to Ampang, a distance of over a hundred miles, there is mineralization on such a scale that the amount of ore *in situ* is sufficient, in very numerous cases, to be profitably worked. If this fact had been realized before the main road and railway through Ulu Selangor had been constructed, it would have been of immense value to the country, for then both road and railway could have been constructed a little to the west of their present position, to skirt the barren quartzite hills, where road metal would be plentiful and, what is much more important, where their positions would leave parts of the valley free to be mined and later to be dumping grounds for tailing. It is not too much to say also that if a geological survey had been made of Ulu Selangor before the main road and railway were built it would have saved the country several hundreds of thousands of dollars for their maintenance, for in their present position they often become silted by tailing from the tin mines.

A striking feature of the veins intrusive in the schists at, and near, their contact with the granite, is the enormous number of quartz veins ramifying through the mica and tourmaline schists. A large number of these, especially the well defined veins varying from a foot to over a thousand feet wide, are undoubtedly formed from the residual acid magma intruded at the same time as the veins of pegmatite and aplite, during the later phase of the granite intrusion, and these represent the most acid part of this magma. The quartz is milky white in colour and of compact, massive structure, but where the veins have long been exposed to weathering agencies, and stand up like huge walls (Fig. 1) above the surrounding and more easily denuded schists and phyllites, the quartz assumes a saccharoidal structure on its weathered surface. Occasionally small nests of well shaped crystals of white and of colourless quartz occur in druses (Fig. 2), and these are frequently accompanied by beautiful crystals of cassiterite and sometimes of tourmaline; and such crystals are also found disseminated through the quartz vein, but chiefly along its edges.

All the quartz veins do not, however, appear to be the result of the intrusion of differentiated magma in liquid form, and a consideration of another mode of origin for some of them is not without interest.

FIG. 1. QUARTZ VEIN AT KUANG, SELANGOR.
It forms a distinct feature owing to the denudation of the surrounding and more easily weathered schists.

FIG. 2. TIN-ORE CRYSTALS.
The larger specimen is from a quartz-tourmaline vein occurring as a granitic intrusion traversing limestone. The fissure vein was not completely filled, and the crystals pointed at right angles to the direction of the vein. The smaller specimen contains crystals of cassiterite in the metamorphosed limestone itself.

It is now fairly well established that by far the greatest amount of cassiterite was brought from below as the vapour of tin fluoride, and that when such a vapour became reduced in temperature in the presence of water vapour, the tin fluoride was decomposed and tin oxide deposited. The extremely active gas, hydrofluoric acid, was liberated, perhaps as below:

$$SnF_4 + 2H_2O = SnO_2 + 4HF$$

This gas, together with any boric acid that might be present, would probably attack mica and felspar to form tourmaline, and alone would attack felspar to form topaz. It is reasonable to conclude that, accompanying the tin fluoride, there was a great deal of silicon fluoride* and a similar reaction would take place between the latter and water vapour, with the deposition of silica or quartz:

$$SiF_4 + 2H_2O = SiO_2 + 4HF$$

It is difficult to account otherwise for the formation of *some* of the small veins of quartz, particularly those having definite lateral and vertical boundaries, by the theory of their intrusion as a liquid granitic magma; and when allowance has been made for the effect in this direction of folding and thrusting of these veins in the highly disturbed schists, yet their forms and the association of the quartz with crystals of cassiterite, tourmaline, and fluorspar, seems to lend support to the view that they are the result of pneumato-hydatogenetic agencies.

It is not proposed to give an account of the very large number of places where tin-ore *in situ* is, or has been, worked in the schists in Malaya, but a few places have been selected to illustrate typical cases, and others as representing interesting peculiarities.

About two and a half miles toward the source of the Sungei Kerling in Ulu Selangor, the rock forming the hilly ground has been washed away by water brought from high altitudes, and the partly decomposed mica schist has been exposed in remarkably good sections. The rock is much disturbed, but has a general strike of 10° east of north to 10° west of south, and a dip of about 55° in a direction 10° north of east. Intrusive into the schist are several veins of kaolin, varying in size from an inch to over three feet wide. The form of the veins, and the fact that they cut in places through the bedding and foliation planes of the schist, show that when intruded the vein rock was not in the soft plastic state it now is.† (Fig. 3). Near the kaolin veins the schist is interlaced by innumerable small quartz veins carrying cassiterite and tourmaline, and between the veins small crystals of cassiterite are disseminated in places through the rock. The schists have been decomposed here to a depth of over a hundred feet, and

* See also Thomas and MacAlister's 'The Geology of Ore Deposits.' Edw. Arnold, 1909, pp. 79, 80, and various American authorities.

†A more detailed account of these kaolin veins and the evidence bearing on 'mineralization' and 'kaolinization' are given in 'Clays of Economic Importance in the Federated Malay States,' by W. R. Jones. Kuala Lumpur Government Press, 1915.

small veins are continuous from the unweathered, and partly weathered rock, into and through the weathered rock, thus proving that the whole deposit is *in situ*. Frequently the mineralization is along definite bands which may be referred to as 'lodes,' and these are followed by the Chinese coolies until the overhanging walls become too dangerous, when

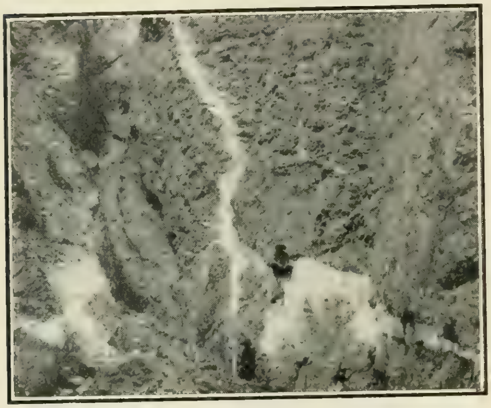


Fig. 3 · Kaolin Vein intrusive into Mica-Schists on the Sungei Kerling, Ulu Selangor.
The cassiterite occurs in small intrusive quartz veins, and frequently these are in pronounced bands, which may be termed 'lodes.'

Fig. 4. Tin Mines at Serendah, Ulu Selangor.
The Serendah hydraulic mine is on the junction of the granite and mica-schist. Numerous cassiterite-bearing quartz veins have been exposed after the removal of the decomposed rocks. The main granite range is seen in the distance.

work is commenced on another 'lode.' Incidentally it may be remarked that there are only two things that can convince the Chinese coolie that a place has become dangerous, and these are 'casualties,' and the Inspector of Mines' court; and of the two a heavy fine in dollars seems more effective than loss of a few lives. There are a number of advantages to the system of working coolies on 'tribute,' but it has the very serious disadvantage of confining the work to the richest parts of the mine and, as is often the case, of making future development very expensive, and frequently impossible.

About a quarter of a mile from Sungei Tempayan to the north of Serendah are two hills forming a very bold feature (Fig. 4). The decomposed schist has been washed away over a large part of one hill near the granite junction, and the rock is seen to contain innumerable small quartz veins carrying cassiterite, some being mere stringers and not any of them very large. There are no distinct kaolin veins cutting through this hill, but thin irregular white streaks of kaolin are frequent.

That part of the Serendah Hydraulic Company's mine between the main road and the back of the manager's bungalow where the granite junction is exposed, is composed of mica schist heavily veined with quartz and carrying, in several cases, a little cassiterite. Some attempt on a small scale was made to crush the vein material with rolls, but the worn out rolls were not replaced. Selected parts of the veins are still being crushed on a small scale by foot-stamps.

The inliers of schist near Peretak (Figs. 5&6) and in Ulu Kanching also contain stockworks, and are being worked. An interesting case occurs about half-way between the northern boundary of Kayu Kapor Forest Reserve and Bukit Unyan. Here a small patch of schists, containing a great deal of tourmaline, occurs in the granite and forms a dark chocolate-coloured patch very different in colour from the surrounding pale grey porphyritic granite. The reddish brown colour is due to the oxide and hydroxide of iron formed, to a great extent, by the decomposition of pyrite and also, in other patches, of tourmaline (*var.* schorl). This part is being worked for tin-ore.

An account of mineralization in the schists and phyllites of Malaya would be incomplete without some reference to the famous lodes worked on the northeast of the peninsula by the Pahang Corporation. A good account of these will be found in a paper read by Mr. F. J. Stephens before the Institution of Mining and Metallurgy in October 1898, and in a paper read before the same society by Mr. W. H. Derrick. The following quotations are from these two papers:

"The lodes run approximately east and west, are from 50 to 2000 ft. apart, and range in thickness from 2 to 10 ft., producing 1 to 15 per cent. of tin oxide to the ton. . . . The granite is overlain by varieties of clay schists, with the tin lodes running down right through the slate into the granite; a few isolated hills of calc-spar remain, although at one time this rock must have covered the slate, as the latter is everywhere seen intersected with veins of spar." (Derrick).

"The geological structure at Sungei Lembing is so remarkably like that of certain parts of Cornwall that the disappearance of the main lodes in depth would be a matter of surprise; even had I not seen the lodes cutting the granite in South Kenau, I should have no hesitation in saying that they would continue through granite if it were encountered. Nor have I any doubt that it will be possible to follow these lodes in granite for considerable distances, seeing that in Cornwall similar fissure lodes have followed the granite for over 1000 ft. The Sungei Lembing lodes are exceptionally rich, they are of great width, and they carry over considerable parts of their course a high percentage of tin-ore." (Stephens).

Figures dealing with the outputs and percentage of ore in these mines will be found in the above papers and also in Sydney Fawns' book on 'Tin Deposits of the World.'

Many important mineralized areas in these rocks, which have proved very rich in tin-ore, for example at Tanjong Rambutan, Ulu Gopeng, Papan, Rawang, etc., cannot be touched in an article of this length, but perhaps sufficient evidence has been given to draw attention to the importance of these lodes and orebodies near, and at, the granite junctions in these schists and phyllites. (Figs. 7 & 8).

Tin-ore *in situ* in the Metamorphosed Limestone.

A remarkable fact about the occurrence of tin-ore in the metamorphosed limestone of parts of Malaya, chiefly in the Kinta district, is the comparatively recent date at which it has been definitely acknowledged that the ore does actually occur *in situ* in this rock. One reason for this is that the orebodies in many places are covered by tin-bearing alluvial deposits, and the other appears to be due to the fact that cases where tin-ore had been previously described *in situ* in limestone in other parts of the world were rare. Even where the orebody had been followed to a depth of 80 ft., the deposit was still described as being of detrital origin.* Later this deposit, known as the Lahat Pipe, was recognized as being *in situ*, and was described as a case of a lode deposit converted into a detrital deposit *in situ*. That at the Jehosaphat mine, to the east of the Kinta valley, however, where percolating waters had in places rounded the ore, was described as a detrital deposit simulating a lode. I have examined practically all the tin-ore deposits occurring in the metamorphosed limestone beds of Kinta, with the exception of the bottom parts of the Lahat Pipe, which is now flooded, and have no hesitation in stating that the evidence that the ore was deposited by mineralizing gases in pre-existing fissures, in the same manner as it was in the orebodies in the granite and schists, appears

Fig. 5. Junction of Granite and Schist below Peretak, Ulu Selangor.
Separating the granite and schist there is a quartz-porphry, evidently the result of the chilling of the granite magma. The three men stand on the three types of rocks.

Fig. 6. Washing for Tin-ore in the Selangor river below Peretak, Ulu Selangor.
Tin-ore is *in situ* in a large patch of mica and tourmaline schist a little higher up the river.

*Scrivenor, J. B. The Geologist's Annual Report for 1904. Kuala Lumpur, Government Press.

to be conclusive. Moreover, the importance of the tin-ore deposits in the metamorphosed limestone of the Kinta district, as the original source of a great part of the ore in the alluvial deposits, seems to have been underestimated to a most remarkable degree. Evidence to show this will be given later.

As far as it has been possible to ascertain it was R. A. F. Penrose, jr., who first described* the occurrence of tin-ore *in situ* in limestone in Malaya, in a mine at Changkat Pari, Kinta district. He states that the ore occurred along a zone of fracturing, sometimes as an impregnation in the limestone, and sometimes as lenses or irregular pockets from 4 to 24 in. wide, and sometimes along other cracks in the rocks, either longitudinally or transversely with the zone of fracturing. It was associated with large quantities of iron pyrite and arsenical pyrite, and smaller quantities of chalcopyrite and bornite, with some rhodochrosite.

The Origin of the Tin-ore in the Metamorphosed Limestone.

There are at least three theories of the origin of the tin-ore deposits in the metamorphosed limestone of Kinta. These are (1) the hydatogenetic theory, or the deposition of the ore through the agency of circulating waters, advocated by Mr. Penrose; (2) the metasomatic theory, or deposition by replacement of the limestone, favoured by Mr. Scrivenor; (3) the pneumatolytic theory, or the deposition of the tin-ore mainly in fissures in the limestone, through the agency of mineralizing vapours, advanced by myself.

Penrose's theory of the origin of the ore in this limestone was to the effect that it had probably been deposited from solution, and that the tin bearing waters that deposited the ore might have derived their metalliferous contents by solution from the disseminated tin in the granite. This supposed hydatogenetic origin of the tin-ore in Malaya has been quoted in numerous text books and articles dealing with ore deposits, and has been used as evidence in support of the hydatogenetic, as against other theories of the origin of tin-ore. This is not the place to enter into a detailed consideration of these theories, and I will content myself for the present by stating that the evidence in support of the theory that the ore was deposited through the agency of mineralizing gases seems to be particularly convincing. Those interested in this question will find some evidence against the hydatogenetic theory in my paper in *The Geological Magazine* for December 1914 under the title 'The supposed case of tin *in statu nascenti* in the Malay Peninsula,' from which the following extract is taken:

"At the bottom of Lahat tin mine in the Kinta valley, Perak, Federated Malay States, a strong spring (not a hot spring) issues from the limestone on which rests the tin bearing ground, and it sometimes happens that this spring brings up pieces of tin-ore of the size of one's fist, and containing well formed angular crystals. This fact has been taken, in some quarters, to support the hydatogenetic theory of the deposition of tin-ore. What happens, however, is that the limestone at Lahat mine, as it has been proved in several other mines in Kinta, contains tin-ore *in situ*, and when the limestone has been dissolved by the water the freed ore is brought up by the underground stream. I have found several pieces of limestone containing crystals of tin-ore at this spot. The water was tested for tin and no trace of the metal could be found."

The Metasomatic and Pneumatolytic Theories.

In his paper before the Federated Malay States Chamber of Mines in 1914, Mr. J. B. Scrivenor stated that "with the exception of small and economically unimportant fissure veins, all these deposits are examples of the replacement of limestone by foreign material. They are cases of the 'metasomatic' alteration of limestone, just as many, if not most, of the tin deposits we meet with in other rocks are replacements of the whole or part of those rocks by material introduced from elsewhere." It is not stated in the printed copy of that paper, which was not primarily concerned with the genesis of tin-ore, what exact meaning its author gives to the term 'metasomatism'; but in another paper on 'The Origin of Tin Deposits,' read before the same society, it is evident that he considers tin-ore as a product of pneumatolytic metamorphism, that is, the result of media other than water and connected with the granite mass. There are objections to the use of the bare word 'metasomatism' to describe mineralization of this kind, for some British writers* have found it convenient to restrict the use of this term to those chemical replacements which take place in rocks through the agency of circulating waters; whereas American writers (to whose important recent researches on the origin of ore deposits we owe so much) and Contin-

*Penrose, R. A. F., jr. *Jour. of Geol.*, Chicago, Vol. XI., 1903, pp. 135-154.

*Thomas, H. H., and MacAlister, D.A., 'The Geology of Ore Deposits,' Edw. Arnold, London, 1909, p. 238.

ental writers hold very different opinions on its connotation and denotation.

The question as to whether these tin-ore deposits *in situ* are the result of replacements or of deposition in cavities by mineralizing gases, or of both, is a big and important one, and it is hoped to treat the question in some detail on another occasion. For the present I will place on record the difference of opinion I hold from that of Mr. Scrivenor on the

FIG. 7. A SMALL BUT VERY RICH OCCURRENCE OF ORE AT PAPAN.
The ore occurred as a small 'lode' traversing the decomposed schists, and beautiful crystals were collected by Mr. Nash, Inspector of Mines, and the author. "Twelve coolies took 6·3 tons of tin-ore between 11 a.m. and 8 p.m. from here on Saturday"—see *Times of Malaya*, Ipoh, July 6, 1914.

importance of 'fissure veins.' Mr. Scrivenor considers these economically unimportant, whereas I am convinced that they represent not only the chief original loci of the alluvial tin-ore, but have proved, and are still proving, of very great importance as ore deposits *in situ*. Even if the ore is the result of hydatogenetic origin, or of metasomatism in the sense taken by Mr. Scrivenor of pneumatolytic metamorphism, or of pneumatolysis, it is impossible to understand how 'fissure veins' can be considered economically unimportant. (Figs. 2, 9 & 10). Amid the divergence of opinion on the origin of ore deposits as expressed in the most recent writings of British, American, and Continental authorities, it is of the greatest significance to notice that virtually without exception all those who have actually studied tin-ore deposits in the field are agreed on the great importance of pre-existing fissures as loci for the deposition of the ore. Moreover, as has been stated recently, "the separation of the metasomatic deposits from the fissure and cavity fillings, as was previously the custom in view of the close relation between the two classes of deposits, can now no longer be maintained."*

That the fissure veins traversing the metamorphosed limestone of Kinta district have been the loci of the deposition of the ore in this rock seems to be placed beyond dispute by the definite directions in which several of the orebodies occur, both in lateral and vertical directions. The following cassiterite bearing veins, for example, are stated by Mr. Scrivenor to have definite directions, namely, one at Menglembu in the direction northeast-southwest; at Penkalen, Ltd., a vein trended toward east-northeast; a vein at Siputeh, about a foot wide, trended northeast-southwest; one at Siak in the direction northeast-southwest, a second from northwest to southeast and a third trended west northwest-east southeast. It is, moreover, interesting that the disposition of these veins, as is the case in Cornwall, are practically parallel, or at right angles, to one another.

Tin-ore has been worked *in situ* in the limestone of Kinta district at Chemor (3 places), Changkat Pari, Menglembu (7 places), Lahat,

* Ore Deposits, by Beyschlag, Vogt, and Krusch, translated by S. J. Truscott, Vol. I., 1914.

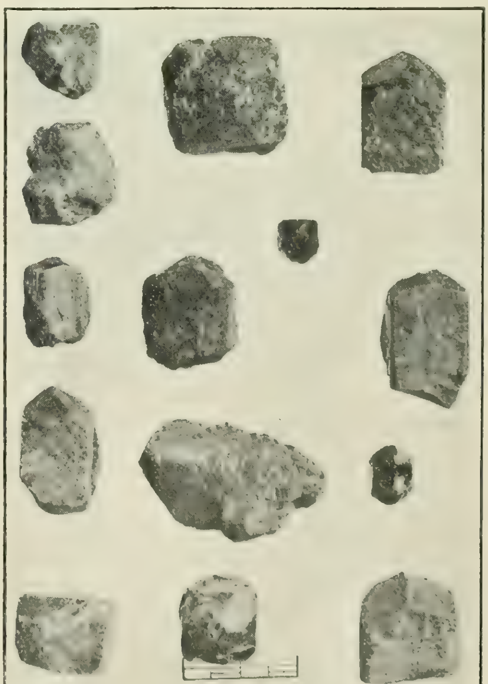


FIG. 8. CRYSTALS OF CASSITERITE.
Those on the left vertical column are from the Papan enrichment, Kinta. The others are from the Siputeh mine, Kinta.

Ager Dangsang, Siputeh (3 places), Siak (4 places), Gunong Lanno, and in many other parts, and hardly a month passes without the discovery of other deposits, some of much economic importance. An interesting account of some of these will be found in the report of a lecture delivered by Mr. Scrivenor before the Federated Malay States Chamber of Mines at Ipoh in 1914. Only the chief orebodies and those possessing peculiarities need be considered here.

The Lahat 'Pipe' and Ayer Dangsang Lode.

Few deposits of tin-ore have proved more interesting than this well known occurrence, in the form of a 'pipe' near the village of Lahat in the Kinta district.* To within about 80 feet from the surface the occurrence had some of the characters of a detrital deposit and was, in fact, described by the Government Geologist when at this depth as being not *in situ*. Evidence of the silicification of the walls was found later, and below the zone where percolating waters had dissolved the calcium carbonate, and where the sulphides and arsenides had been oxidized, the deposit had all the appearances of a typical lode deposit. The orebody was in the form of a very irregular pipe, having a vertical section not unlike the appearance on a map, held vertically, of the course of a meandering stream flowing from north to south through a narrow lake, the length of which was at right angles to the course of the stream. An occasional small cave was encountered where the percolating water had dissolved away the limestone, and hence where a concentration of alluvial ore occurred.

At Ayer Dangsang, nearby, the 'pipe' in which the orebody occurred had not offered such a convenient channel to surface waters, with the result that even near the surface of the limestone the cassiterite, pyrite, pyrrhotite, mispickel, and sulphide and carbonate of copper were so obviously *in situ* that no one ever questioned their origin. A considerable amount of copper pyrite occurred in association with the pyrite, mispickel, cassiterite, etc. There appeared to be good evidence that the percentage of copper minerals decreased in depth in this pipe, as it is known to do in some of the Cornish mines, but water trouble caused the mine to be abandoned, at least for a time.

Mr. Scrivenor has pointed out that the Lahat pipe and the Ayer Dangsang lode have two points in common, namely, the rarity of quartz and tourmaline. Parts of the Ayer Dangsang lode, however, showed the presence of small quartz veins, but they could not be considered important except in their very probable connection with the granite, of which they probably represent the most acid part of the residual magma intruded during the later phase of the main granitic intrusion, and the evidence they showed on the mode of origin of the tin-ore.

The Orebodies at Menglembu.

A very good opportunity of examining these orebodies occurred before the shafts became flooded. There were three different orebodies being worked in the metamorphosed limestone near the village of Menglembu, but it is unnecessary to refer to them separately in this article, as two of these orebodies are quite close to each other, and it would not be surprising to find that future development will prove, as certain indications suggested, that these were connected at depth. One orebody had been worked to a depth of over 250 ft., and at this depth the mineralized ground had been proved to measure 50 ft. by 30 ft. by 30 ft. It was impossible to decide satisfactorily on any probable lateral direction taken by the orebody, but in the neighbouring 'pipe' there were definite indications of a general direction in the neighbourhood of northeast–southwest.

In the three workings there was clear evidence of faulting and thrusting in the limestone. Mr. Scrivenor states* that there was no evidence of the faulting influencing the run of the ore, and that there was a distinct section showing the ore cutting through the plane of the fault in such a manner that it was clear it had been formed after the fault plane, and independently of it. My own observations in these mines led to the conclusion, however, that there were at least two sets of faults, those prior to the deposition of the tin-ore and in the fracture planes of which the ore had been deposited, and another set of faults subsequent to the deposition of the ore. A photograph (Fig. 9) to illustrate such a case is given, showing a specimen from a faulted vein of tin-ore intrusive in this limestone, from Siputeh mine.

On one of my visits to the Menglembu mines I was shown, by the courtesy of the Chinese manager, figures which stated that the output of one of these mines, the largest, was over 500 piculs (28 tons 8 cwt.) of tin-ore per month. The percentage of ore in

* An interesting account of this 'pipe' by J. B. Scrivenor, the Government Geologist, is given in *Q.J.G.S.*, 1909, pp. 382—389.

* Scrivenor, J. B., 'The Deposits of Tin-ore in the Limestone of Kinta Valley.' F. M. States. *Times of Malaya* Press. Ipoh, 1914.

the material crushed for the previous month worked out at 19·4%.

Siputeh and Siak Veins.

These two places are within a short distance of one another, and tin-ore definitely *in situ* has been worked from time to time at both places during the last fifteen or so years. The cassiterite-bearing veins traversing the limestone become exposed after the cover of alluvium, also tin-bearing, has been removed. The following minerals have been noted in this neighbourhood by the staff of the Geological Department: cassiterite, arsenopyrite, pyrite, pyrrhotite, ilmenite, magnetite, muscovite, zircon, rutile, brookite, monazite, tourmaline, and apatite.

A fact of much interest and of great significance with reference to the tin-ore found in the clays at Siputeh is that, in support of his theory of the glacial origin of the tin-ore deposits of Kinta district, Mr. Scrivenor refers to the angularity of the ore at Siputeh as a proof that it has be transported by ice. Now that tin-ore has actually been found *in situ* on this mine by following certain directions, agreed upon between the general manager and myself, there is a simple and obvious reason why the ore preserves its angularity.

Origin of the 'Pipes.'

Attention has been drawn by the Government Geologist to the similarity in form between some of the orebodies occurring as 'pipes' in the limestone and those also found in the granite, and he has summarized the differences in their mineral characteristics as follows:

Pipes in Granite.	Pipes in Limestone.
Tourmaline is abundant.	Tourmaline is very rare.
Tremolite has not been found.	Tremolite is common.
Fluorite is not common.	Fluorite is common.
White mica occurs where the ore is rich.	Very little white mica or lepidolite is known.
Metallic sulphides are not very abundant.	Metallic sulphides are very abundant.

Space will not permit a detailed inquiry into the cause of these differences, and this has already been done, in the interesting paper quoted above. An inquiry into the reasons why some of these orebodies are in the form of 'pipes,' however, is not without interest. Mr. Scrivenor states that "It is possible to imagine the formation of a pipe in the latter (the limestone) as something comparable to the effect of a thin jet of steam being directed against a block of ice, but the jets that cut through the limestone carried a quantity of tin in some form, and the pipes are special cases of alteration of limestone persisting to a great distance, at least 300 ft. from the granite margin, as shown by the Lahat pipe." I do not agree that these orebodies are in all cases the result of the *alteration* of the limestone, but maintain that the ore was in several instances

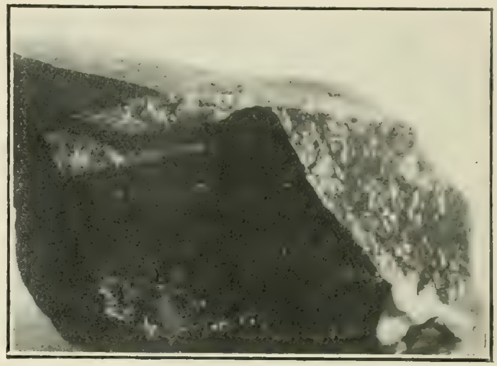


Fig. 9. From Siputeh mine, Kinta.
Cassiterite in a fissure vein in a quartz-tourmaline rock, which traversed the metamorphosed limestone. The vein as a whole was about 18 in. wide, and was faulted about 3 ft. Such fissure veins are very common.

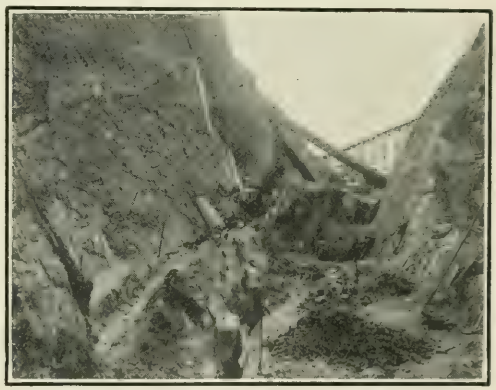


Fig. 10 Tin mine near Perektak, Ulu Selangor.
Following small lodes in granite, which has decomposed, in places, to a depth of over 100ft The bulk of the ore occurs here in fissure veins.

deposited in fissures which, in places, became widened by the sudden expansion of the magma when it reached areas of less pressure, and very soon afterward became the loci of the tin-ore deposits. It has been proved by Daubrée* that exploding gas can drill a pipe-like channel though apparently solid granite, at the same time polishing and grooving the walls by the attrition of the particles driven through it; and Iddings, in a recent

*Daubrée, A. Etudes Synthétiques, Paris, 1879, p. 669.

publication,* makes the following statement:

"Explosions may take place in magma that is rising in a fissure as it approaches the surface of the earth, where the weight of the overlying load may be insufficient to suppress the gases, or where the magma may encounter strata rich in water, which would become superheated by the molten magma. This might result in widening the fissure, and possibly forming a pipe or funnel-shaped opening spreading toward the surface."

The descriptions given in the October number of this Magazine of the orebodies in the form of 'pipes' in the granite at Menglembu, and the megascopic and microscopic characters of the mineralized rock† (p. 201) seem to offer conclusive proof that the ore was deposited in the granite in previously formed fissures, and the evidence gained in the field points to the conclusion that the 'pipes' in the metamorphosed limestone, a very short distance away, are also the result, for the most part, of the deposition of the ore by mineralizing gases in similarly formed fissures.

CONCLUSION.

It has been impossible to treat many points of scientific and economic importance as fully as they deserve within the compass of this article, and several very interesting questions on the mineralogy of cassiterite have not even been touched. It is hoped, however, that sufficient evidence has been given to show that lode and other ore deposits of great importance occur in the granite, in the schists and phyllites, and in the metamorphosed limestone of Malaya, and that it is on the tin-ore occurring there *in situ* that the future mining prosperity of that country will depend.

It is of the greatest significance that not one of the many 'pipes' in the granite and metamorphosed limestone has been worked to a depth where the ore has given out, and a consideration of the formation of these 'pipes' leads to the conclusion that they probably persist to a considerable depth. The conduit through which the mineralizing gases passed may, in places, become very confined and even faulted, but so far what has determined the depth to which the 'pipes' have been followed is not the non-persistence of the ore, but the accumulation of water, which has given serious trouble. To anyone familiar with mining, and especially coal mining at great depths in wet districts, the water problem does not appear to be an insuperable one. An arrangement by which powerful pumping plants are maintained by a group, or groups, of mines, as is done in some colliery districts, may some day enable the level of saturation of the limestone of the Kinta valley to be kept at a depth which will enable the most promising 'pipes' to be worked several hundreds of feet below their present depths.

*Iddings, J. P. 'The Problem of Volcanism.' New Haven. Yale University Press, 1914, p. 225.

†*The Mining Magazine*, October 1915, p. 201, Fig. 8, Fig. 9.

African Railways.

The development of Africa by means of railways was the subject of a lecture by Sir Charles Metcalfe before the Royal Geographical Society last month. Sir Charles has been engaged in the construction of railways in Africa for thirty years, and to him and to Mr. George Pauling must be given credit for much of the pioneer work inspired by Cecil Rhodes. In his lecture he showed that the industrial development of Africa depends largely on railways. The African coasts are bounded by steep declivities from central plateaus, and in consequence the navigation of rivers is rendered impossible or extremely difficult by falls and rapids. This fact accounts for the comparatively slow development of the continent. A formidable barrier to its full development is caused by the lack of uniformity in the gauges of the various railways, and Sir Charles advocates a general reorganization of gauges before more extensive building is undertaken. The first railway built in 1855, from Cape Town to Wellington, was of the standard 4 ft. 8½ in. gauge, but this gauge was altered to 3 ft. 6 in. by the newly established Cape Colony government in 1873. This narrower gauge has ruled ever since in the Union of South Africa and Rhodesia. In British East Africa the metre gauge was adopted for the line from the east coast to Victoria Nyanza, and in Portuguese East Africa the gauge is ¾ metre. It is difficult to realize that railway communication did not extend to Kimberley before 1885 and to Johannesburg before 1892. The Rhodesian railway reached Bulawayo in 1896, crossed the Zambesi river at Victoria Falls in 1904, and reached the Congo State border in 1909. The line in British East Africa from Mombasa to Victoria Nyanza was completed in 1902, and in German East Africa the railway from Dar-es-Salaam to Ujiji on Lake Tanganyika was completed in 1914. In Portuguese West Africa the Benguella railway has reached the high plateau, and is being extended over a level stretch of country to Katanga in the Belgian Congo.

DISCUSSION

Health on the Rand.

The Editor:

Sir—At the September 1913 meeting of the Chemical, Metallurgical, and Mining Society of South Africa, I read a paper on 'The Ventilation of the Mines of the Rand: the Problem of Obtaining Healthier Conditions.' This paper dealt fully with the conditions which obtain in the mines of the Rand, and showed why it is that ventilation by means of an exhaust fan at the surface fails to achieve a beneficial result. I advocated pumping air from the surface to the workers at the various faces through pipes by means of a blower of the Root's or similar type, and gave an estimate of the cost of such an installation. The discussion on my paper, although it extended over several meetings, was disappointing, for practically only side issues were raised. One speaker said it was not practicable to pump air to the working faces through pipes, but he advanced no reasons in support of his statement. Of course there have been people from the time of Stephenson's locomotive to the aeroplane who have made similar bald statements. However, I have carried out my suggestions in three instances with satisfactory results both as to cost and ventilation of the mine workings.

While my paper was under discussion at the Chemical, Metallurgical, and Mining Society, I was told by several people connected with various mines that spraying and fan ventilation had solved the problem of prevention of miners' phthisis and that anything further in the way of ventilation was quite unnecessary. Today it is generally admitted that miners' phthisis among the miners of the Rand mines is quite as prevalent if not more so than at any period. Engineers acquainted with the various devices that have been tried to precipitate fine dust in smelting furnace gases have known all along that if all the regulations for spraying underground were strictly carried out they would not lessen the amount of *fine* dust in the atmosphere in the mines. Spraying will only affect the coarser particles of dust. Also the greater portion of the fine dust contained in the underground atmosphere is caused by blasting.

The annual report of the Mines Department (1912) states: "If health conditions were improved better men would compete for the comparatively high wages on the Rand; both white and coloured men would put in a better day's work, and it is reasonable to suppose that more intelligent men would tend to reduce the accident rate. If these arguments were considered insufficient from a humanitarian point of view, it might be further urged that improved health conditions, by bringing better and more efficient miners, might tend to actually reduce working costs and cause larger profits to be made. Working under unhealthy conditions, the efficiency of the skilled miner must remain low, and a larger number of persons must be employed to do a certain amount of work than would be under normal conditions. As regards white miners, the skilled miner with all his faculties clear and in working order, breaks more ground and uses less explosives than a mere labourer, and the difference between placing holes rightly or wrongly is very great indeed and has a far reaching effect, not only on the immediate output from the mine but on the future cost of timbering and supporting weakened excavations."

Since the above was written skilled miners in the Rand mines have become fewer. The practical certainty of contracting miners' phthisis causes good miners to avoid Rand mines. Also parents will not allow their sons to join the mining schools and classes that have been established. The dread of this fell disease causes all hands, officials as well as miners and labourers, to come up from underground at the earliest possible moment. Is it therefore surprising that the cry is for more 'boys' and still more 'boys,' so that the required daily tonnage for the mill shall be broken as quickly as possible? Human beings will not voluntarily remain in a death-dealing atmosphere. In the annual report of the Mines Department, 1912, quoted above, occurs the following: "If health conditions were improved better men would compete for the comparatively high wages on the Rand; both white and coloured men would put in a better day's work." To make the significance of this statement clear to the lay mind, it should be said that many engineers on the Rand who are competent to judge consider that if health conditions were improved the number of workers underground, both white and coloured, could be reduced by one-third, and still maintain the tonnage output of ore. To reduce the foregoing to figures it means that better health conditions would reduce the cost of mining from two to four shillings per ton. On the present tonnage output this represents a sum of from £2,500,000 to £5,000,000 per year.

The present unhealthy conditions at the Rand mines, which conditions are remediable, mean an annual loss to the shareholders of from £2,500,000 to £5,000,000. Unless health conditions are improved mining costs will increase. If they are improved, and they can be, there will be a reduction in the immediate future of from two to four shillings per ton of ore, and this reduction in mining costs will increase later, as the underground officials and skilled miners "with all their faculties clear and in working order" devote their brains and experience to effecting economies.

The gold-mining industry of the Rand has a very long life before it, and this life will be further prolonged if mining costs are reduced. Such a reduction is possible that gold ore can be worked at a profit that has at present no commercial value. Not only do the health conditions of the Rand mines affect the lives of the underground workers and the shareholders' pockets, but they have a very great influence on the future development of South Africa.

G. H. BLENKINSOP.

Johannesburg,
November 3.

[The importance of good health conditions in the mine is something that cannot be exaggerated, but we believe that our correspondent unduly minimizes the benefit of the work already done. The first effect of closer inspection and the introduction of a system of benefits is always to increase the number of apparent cases of damage. The actual number, of course, is not affected. On the Rand it has been the belief that the accumulated load of miners' phthisis cases was being cleared away, and that new conditions had already made for substantial improvement. We refer to this matter on another page. Much remains to be done, but much is being done. Better ventilation is one factor in improving both health and general mining conditions, but doubtless a much greater increase in efficiency would result if the white miners on the Rand could in some way be brought to look at their work as do those in Canada, the United States, and other countries, than from any other improvement. Efficiency will always be low on the Rand so long as real work is only honourable for a black man, and at the same time there is an arbitrary (though perhaps necessary) limit to promotion for him. We may not be able to change these matters, at least not rapidly, but it will induce to clear thinking to recognize them. As to ventilation by forced air or exhaust, both systems have their advantages and their disadvantages. Both are in use in collieries, and with great satisfaction. Ventilation by means of pipe and blower, such as Mr. Blenkinsop suggests, is also in successful use in metal mines, though we have never seen it in any with workings measured in miles. It would seem that the experience of colliery engineers, who use the entire cross-section of a drift rather than the limited cross-section of a pipe, and hence reduce the pressure necessary for circulating an air current, ought to be sufficient for any ventilating problems that metal miners may encounter.—EDITOR.]

Tin and Tungsten in the West of England.

The Editor:

Sir—I have read with considerable interest the article by Mr. J. H. Collins in your October issue with regard to the tin and tungsten deposits in the West of England, and also the contribution by Mr. E. Terrell in your November number.

There is, however, one district in Cornwall not mentioned by either of the two writers, which in my opinion is an important mining field for tungsten ores. I refer to the Bodmin Moor district in East Cornwall, lying to the north of the town of Liskeard and to the west of Launceston. Most of the tin-wolfram deposits of this part of Cornwall are situated in the vicinity of the villages of Altarnun and Fivelanes, and I may mention such mines and prospects as the Vincent, Horseboro', Treburland, Liskernik, Cannaframe, and Halvana.

About eight years ago I had occasion to investigate some of the alluvial deposits of the Bodmin Moor district, and I was then struck by the marked indication of the abundance of the tin-wolfram lodes traversing this part of Cornwall. The veins or lodes in this region occur chiefly in granite, and vary from a few inches to six or seven feet. Two notable examples of the occurrences of wolfram and tin are the above mentioned Vincent and Treburland mines, where the ore occurs mixed with pyrite and arsenical pyrite and small quantities of titaniferous minerals.

According to local information, the Vincent mine some years ago produced appreciable quantities of tin concentrate, and the method then employed for getting rid of the wolfram was the Oxland process which consisted in furnacing the ore with carbonate of soda and leaching out the tungstate of soda, which was run to waste.

The sampling of some of the lodes in the district showed me that the mixed mineral varied from 1½% to 2% of wolfram and tin. It will probably be found, if serious mining is undertaken, and I am informed that some scheme is under consideration to open these various mines on a reasonable scale, that the ore milled in the district will probably average 1½% of mixed tin-wolfram.

In addition to the lode mining, various attempts have been made in this neighbourhood to work the alluvials, by dredging and other methods, but apart from small parties of streamers who in the past produced not inconsiderable quantities of tin from these alluvial deposits, as can be seen from the extensive old workings, practically the only successful recent work in the district has been carried out at Buttern Hill and some of the adjoining marshes. I am informed that Messrs. King are now producing about four tons per month from Buttern Hill and adjoining ground of high grade wolfram by means of a small hydraulic installation at a low working cost.

Particulars of the geology of the neighbourhood have been fully given by Mr. George Barrow, of the Geological Survey, and I will not repeat nor touch upon this part of the question. It remains to be seen whether the wolfram-tin deposits will hold out in depth.

Another point in connection with the character of the ore is that the cassiterite and wolframite of the district are considerably coarser than these minerals in the west of Cornwall, but this may be partly owing to the fact that no depth has yet been reached. I am convinced that if energetic developments were undertaken in the Bodmin Moor district quite considerable quantities of wolfram could be obtained before long for use in this country. There is no need to draw attention to the importance of wolfram in view of the present unprecedented demand for this mineral in connection with the manufacture of tungsten metal and high speed tool steel, and it is to be regretted that the Government, as far as one can learn, has not up to the present taken any active part in the exploitation of these various deposits of tungsten in the Bodmin Moor and other districts of Cornwall.

O. J. STANNARD.

London, November 30.

The Vanning Assay.

The Editor:

Sir—In reading the article on 'The Vanning Assay' by Mr. Maynard in the November issue of the Magazine, I was struck with two things. One was the use of the word 'tin' when the obvious meaning was 'cassiterite.' It seems to me in such an article care should be shown in the use of terms. The other was the use of the half-ounce as the weight of ore taken for the test. It may be convenient as a starting point for the work, but in weighing the result the gramme is not equal to exactly 9 lb., being in fact 9⅛ lb. I would suggest that 224 grammes be taken at the start. If this were done, then each gramme of product would be equal to 10 lb. per ton. It would be easy to make the necessary weights.

FRANCIS DRAKE.

London, November 24.

[Use of the name of the metal in place of the mineral is only too common around mines, and many a mill man talks of lead and zinc when he really means galena and blende. We have known districts on the other hand where galena and even pig lead were commonly known as 'mineral,' and in one big copper mining district the ore goes through 'rock' houses for sorting, while the mills recover 'mineral,' though in this case it is metallic copper. We might all be more careful to good advantage.—EDITOR.]

Standardization of Screening Tests.

The Editor:

Sir—In your November issue reference is made to the recommendation of a committee of the Mining and Metallurgical Society of America as to the adoption of a standard scale of wire cloth screens for laboratory use, in place of the standard in use by the Institution of Mining and Metallurgy; and as this subject will doubtless be under the consideration of many engineers of both societies, I beg your permission to submit a few remarks, my excuse being that I was chairman of the 'Mesh' Committee which reported in December 1906.

As there are many engineers today who have forgotten the circumstances in which the standard was adopted, and many more who never heard of them, it is desirable to point out that the decision was not an arbitrary one of either a committee or of the full Council of the Institution of Mining and Metallurgy; but it followed on a ballot of all the membership, and after consultation with the councils of other societies abroad. As the submission to members was after much preliminary discussion and the adoption of various modifications suggested, the final ballot showed a rather remarkable approach to unanimity. It is true that since the adoption there has been some criticism, but most of this has been from a point of view of theoretical considerations which conditions of screening tests could never satisfy, and has arisen from ignoring the main object in view when the standard was adopted. Possibly the march of science may have weakened some arguments of 1906 and strengthened others, and practice may have shown weaknesses; but certainly some important considerations remain unchanged, and should be kept in mind in any decision as to the erection of a new standard.

The decision to make a new set of screens as a tool (or, at least, a reference) common to all, was based on the very obvious imperfections and irregularities of commercial screening. Microphotographs taken by Mr. Sulman of samples of commercial wire cloth showed variations of from 11 to 22% in the apertures. The American society recommends the commercial standard catalogue of one maker, but unless that maker is free from the human and technical irregularities of wire drawing and weaving, it is safe to maintain that in a new piece of any mesh (and, more still, after some use in the laboratory) there will be such variations between areas of aperture as will make the fourth place of decimals describing them look very unnecessary. In view of this well known irregularity of aperture in any commercial screening, and considering the shifting and wear of wires in use, also the differences in form of particles of different ores, and the personal equation of the man who sifts, it has been often pointed out that screening tests are not scientifically accurate, and refinements as to ratios are often mere pretences of accuracy. Even assuming that a commercial line of screening is as uniform in wire and weaving as the specially manufactured small quantity of standard cloth, made to the order of the Institution of Mining and Metallurgy for the purpose of securing uniformity, the following table will show that standards of the Institution are so close to those of the American society that it would be absurd to say any scientific advantage of ratio of aperture could be secured by the use of the latter. The few cases of sensible differences are still smaller than the errors above mentioned as incidental to all screening tests.

Proposed Standard.		Nearest I.M.M. Standard.	
Mesh.	Aperture.	Mesh.	Aperture.
200	0·0029	200	0·0025
150	0·0041	120	0·0042
100	0·0058	90	0·0055
65	0·0082	60	0·0083
48	0·0116	40	0·0125
35	0·0164	30	0·0166
28	0·0232	20	0·0250
20	0·0328	16	0·0312
14	0·0464	12	0·0416
10	0·0656	8	0·0620
8	0·0928	5	0·1000
6	0·1312		
4	0·1855		

If it be accepted that screening is merely an approximate classification and can never be a scientific measurement of particles, the above figures show that the I.M.M. standards would secure practically the ratio aimed at by the American society, with the added advantage that the mesh descriptions are in accurate relation to the apertures.

One object of the I.M.M. standardization was to retain the very practical advantage of description by 'mesh,' while also establishing a fixed relation between mesh and aperture; so that an engineer using any wire cloth he preferred and any ratio between apertures he fancied in a test, could still translate his results into terms of mesh understood by all other engineers. Description by mesh is convenient, it is established, and it is comprehensible in reading or talking, which figures of aperture to the fourth place of decimals are not. It happens, as pointed out by Mr. Stadler, that by selection of certain of the I.M.M. standards the ratio of the cube root series, within the limits of practical accuracy, can be used; and Mr. Stadler, Mr. T. J. Hoover, and other engineers have made strong arguments in favour of this series for crushing tests. There is a further advantage in the fact that convenient decimals of the metric measurements are secured. My object in writing is not to argue the relative advantages of the two standards, but to show there is sufficient to be said for the old one to justify asking the American societies to consult with the English Institution before any definite action is taken; so that at least some attempt be made to lessen the inconveniences of having two standards, if it be only in the way of correlation in all publications.

WALTER MCDERMOTT.

London, December 6, 1915.

SPECIAL CORRESPONDENCE

JOHANNESBURG.

Gold Production and the War.—The satisfactory returns for September, giving details of the output of gold on the Witwatersrand, not only constitute a record, but afford an indication of a possibility of this year's output approaching, if it does not exceed, the record output of 1912. This if attained will be a magnificent achievement, not only on account of the war and consequent disabilities under which the mines suffer, but because it will tend to refute the opinion gaining ground of late that the inevitable decline in the gold output of the Rand has already made its appearance. At the present time little is being done to compensate for the exhaustion of some of the best mines on the Central Rand, and that little is confined to the Far East Rand. As a matter of fact it is only on the Far East Rand that any possibilities exist of new mines being opened, but the time required to open and develop these makes it doubtful whether this virgin ground can be made productive before several producing mines to the west are exhausted.

Geological Museum. — Surprise is expressed that in such a mining centre as Johannesburg it should be even hinted that difficulties are likely to arise with regard to the up-keep of the Geological Museum. It really does seem strange that, in the centre of the richest and largest goldfield in the world, any difficulty in this respect should arise. One would suppose that from the Witwatersrand goldfield itself sufficient interest in its geological structure and features would be taken as to support a museum by itself to illustrate its principal features. Yet the other day it was reported that the Municipality of Johannesburg had decided for economy's sake to discontinue the usual grant toward its support, which would mean that it would be impossible to retain the services of the Curator of the Museum. Such a condition of affairs is not creditable to the town, the Chamber of Mines, or even to the individual gold mines, because, although it may not be generally recognized, the gold mining industry of the Rand owes much to geological science.

There has unfortunately always been a feeling on the Rand that geology has done little to aid development, because no new reef discovery can be placed to its credit. Then again it is pointed out that so little interest was taken in the geological structure of the Rand that even the Government left its Geological Survey severely alone until quite recently. The explanation is that from the date of its first discovery, so much interest was taken in its geology, and so much work was done on its limited area, that it was considered that there remained little to elucidate with regard to its main geological features. Many eminent geologists have from time to time visited and reported upon the Rand, while local geologists such as Molengraaf, Hatch, and Draper have probably done so much geological work there that when the Geological Survey did commence operations it was considered that there was little new light to throw upon its geology. Dr. Mellor, of the Government Survey, has during the last three years, however, shown that there was still much to learn with regard to several geological features of the Rand, and it is now generally recognized that it would have been better had the Government Geological Survey started its operations earlier. There is no doubt that an earlier detailed Geological Survey of the Rand would have saved the expenditure of much money, and the circulation of many foolish theories with regard not only to the various reefs but also with respect to the whole geological structure of the Rand. Nevertheless now that the Government Geological Survey has been concluded, and its geology placed on a sound footing, there ought to be all the more reason why a well equipped Geological Museum should be maintained on the Rand.

Heidelberg Goldfields. — There is perhaps no district of the Transvaal where so much money has been lost in prospecting, mining, and speculation, as at Heidelberg. Unfortunately, although the goldfields are an extension of the Witwatersrand goldfield, with the same geological features, the country is so broken as to render its geological reading more than usually difficult. Moreover, the Government Geological Survey of this district has not yet been made, and there is so far little of an authoritative character to aid the prospectors in their work. It will be remembered that this district was the scene of the Coronation fiasco, which, had the district been properly surveyed, would probably never have taken place. For this and many other reasons it is hoped that the Government geological survey of the Heidelberg district will not be unduly delayed. In the absence of such a survey this district seems the only one section of the goldfields where there is left any room for speculative geology and the formation of speculative prospecting syndicates. For instance, under the title of the Southern Van Ryn Reef Gold Mining Co., Ltd., a company is being formed to prospect and purchase nine hundred claims near the Nigel mine. The statement is made in the prospectus that it has been discovered that the Nigel reef really occurs at the lower horizon than the Van Ryn reef. It has always been held by leading geologists that the Van Ryn and the Nigel reefs are contemporaneous, so the results of prospecting operations by the newly formed company will be watched with interest. It seems strange that if the Van Ryn reef lies over the Nigel reef it has not been discovered by the Nigel company, which has done so much boring, shaft-sinking, and prospecting in this neighbourhood. In the face of so many alleged wonderful discoveries made in the past in the Heidelberg district that have always resulted in failure, this alleged new discovery will, until proved otherwise, be regarded with suspicion, more especially as the idea is entirely opposed to the prevailing views of leading geologists.

SAN FRANCISCO.

THE RARER METALS are in much demand, and hence the attention of prospectors all over the West is accordingly turning to the finding of minerals yielding tungsten, antimony, manganese, molybdenum, vanadium, and uranium. The arrival in Western mining districts of buyers for ores of these metals at apparently fabulous prices has quickened interest to an unusual pitch, and the newness and strangeness of searching for such ores instead of for the old stand-bys of gold, copper, and silver, have worked a mild revolution for the time being. Reports from Colorado indicate activity in tungsten-mining in Boulder and Gilpin counties, which have been producing over five-eighths of the United States production; the ore there is ferberite, the tungstate of iron, occurring in narrow veins of an average width of one foot, and generally requiring concentration before shipping. Molybdenite discoveries have been made near Breckenridge in Summit county. Henry Wood, metallurgist, of Denver, has been buying molybdenite ores, particularly from British Columbia, running as low as 5% molybdenite, which he concentrates to 75% by his flotation process. [Some notes on British Columbia production are given in our Précis.] The product is in most demand when concentrated to over 85% MoS_2, and when free from copper, arsenic, bismuth, and tungsten. In Arizona, tungsten discoveries have been made in Powers gulch near Globe; also at the Williams mine near Kingman in Mohave county, where the Oatman gold boom has been attracting attention; at the American Tungsten Co.'s and Primos Chemical Co.'s claims in the Whetstone mountains; and at the Tip Top silver mine in Yavapai county. Arizona's molybdenite occurs with other sulphides, making separation difficult. Staking and patenting of claims has been in progress in Utah, particularly as regards carnotite, on account of its vanadium, uranium, and radium contents.

THE STRIKE in the Arizona copper districts of Clifton and Morenci continues unsettled, and operations are at a standstill. The situation as to rights and faults can be described as mixed. Various individuals, party to the troubles, make contradictory statements apparently equally well founded on fact. In general, the narrow margin of profit of the three mining companies, particularly the Shannon Copper Co., had necessitated lower wages to the Mexican labour than prevails in other Western mining regions where American labour is employed; while on the other hand the men showed bad judgment in identifying themselves with the Western Federation of Miners. The company-stores and one or two other little grievances intensified the feelings of the miners. The three mine managements, of which the other two are the Arizona Copper Co., a Scotch company, and the Detroit Copper Co., a subsidiary of Phelps, Dodge & Co., have maintained a firm refusal to recognize the Western Federation of Miners, and seem inclined to fight the matter out at no matter what cost.

COPPER, ZINC, AND LEAD mining in the country is prospering generally. At Butte, in the Coeur d'Alene, in Utah, at Joplin, in the Lake Superior region, etc., production is at the highest figures for months. The October output of the Anaconda company, 24,900,000 lb. of copper, happened to equal exactly the output of the Lake Superior mines during the same period; it is estimated that Michigan will produce 240,000,000 lb. in 1915 as against 230,437,992 lb. in 1905, the greatest year.

Utah Copper produced 15,000,000 lb. in October which, it is evident, is much above the rate of production in 1914, when 115,690,000 lb. was produced; Ray Consolidated produced 5,131,466 lb. in September, Nevada Consolidated 6,021,850 lb., Chino 5,254,286 lb. The Kennecott Copper Co. of Alaska produced 10,000,000 lb. in October, with $1,300,000 profit.

MEXICAN matters are the object of awakening hope. With the recognition of Carranza and the giving of the United States government's support to this leader, mining men, who have been forced out of the country and have been waiting patiently for the resumption of responsible authority, are saying that they hope to get back to their mines and interests by spring at least. The secret of control of the country lies in the railroads; it was by his ability to use them that Porfirio Diaz maintained his power for thirty years or more and nipped all rebellions in the bud. We are expecting daily to hear of the dispersal of the Villa forces and the news that their leader is a fugitive on American soil. With the prestige and assistance given to him by the United States government, Carranza should be able to subdue and reorganize the northwest corner of the country until recently held firmly by Villa. However, the restoration of order and the resumption of industry must await the repair of the main lines of railroad from El Paso and Laredo to Mexico City.

NEW YORK.

KENNECOTT COPPER. — The principal event of the past fortnight in the mining world is the combination recently announced whereby the Kennecott Copper Co., as a holding company, takes over the Braden and a working control of the Utah Copper. The move is a most significant one in that it emphasizes the manner in which all copper interests have come to lean upon the mines with large bodies of low-grade ore. Kennecott was heralded when found as one of the "wonders of the world," and was called "a mine to be ranked with the greatest ever discovered." It is undoubtedly a great mine and has yielded millions of pounds of copper ore of amazing richness, many cargoes assaying 72 per cent. But $22,000,000 or more was spent in building the Copper River railroad to afford it an outlet, and in the development of the mine. About July 1 the shares were offered for public subscription at $25, later selling up to $60. The mine has been a dividend payer for two or three years, during its operation by a close corporation. If, as has been stated, the Kennecott is to prove to be another Copper Queen, which prophecy is thought by many to be justified, it will, of course, be a dividend payer for many years; but there has existed, nevertheless, the desire to stabilize the future of the company and give to it something of the same investment character as that of Utah, Chile, and Braden. This is the real solution of the puzzle that was presented to the public when it was announced that a new giant concern was to be formed to include Kennecott of Alaska, Braden in Chile, and the interest in Utah heretofore held by the Guggenheim Exploration Co. Not all of the details have as yet been arranged; in the main, however, the new move contemplates either a new holding company or an enlarged Kennecott. When this first step has been completed, the Braden shareholders will be asked to exchange their stock for the new Kennecott shares, which will be without any par value, on a basis of $3\frac{1}{3}$ Braden for one new Kennecott; this offer will be open to all Braden holders and will be reinforced by the action of an independent syndicate which will make an alternative offer of cash to such Braden holders as are unwilling to make the exchange. The exchange of the Utah shares to be made will not be open to all holders, but will include only the shares now in the treasury of the Guggenheim Exploration Co., amounting to 404,504 shares, and possibly some part of the personal holdings of the Guggenheims. For this stock the new or enlarged Kennecott will issue its own stock on a basis of $1\frac{1}{2}$ for 1, so that the Guggenheim Exploration Co. will receive 606,756 shares of new stock. The present Kennecott holders are not to be disturbed. They will either retain their present holdings, or in case of the formation of a new company, will be taken in share for share. Next in importance to the concentration of this control in the Kennecott is the early dissolution of the Guggenheim Exploration Co., whose most important asset is the Utah stock mentioned. The Kennecott shares received in exchange will be distributed *pro rata* to shareholders, coupled with an alternative offer of cash. In addition to the Kennecott shares the Guggenheim Exploration Co. will also distribute its holdings in other companies as follows: 97,750 shares of Chino; 154,300 shares of Ray Consolidated; 69,500 shares of American Smelting & Refining common; and 2,842,625 shares of Yukon Gold; and $14,000,000 in cash. There are many details not yet adjusted, including the item of Braden's floating debt of $5,500,000 owing to the Guggenheim Exploration Co. and being a part of the cash item of $14,000,000.

The new company will be one of the most important factors in the metal market, though there will in reality be no particular change in this regard. Mr. Murry Guggenheim and Mr. Joseph Clendinnin have for years handled the sales of copper for all the Guggenheim organizations, and there is no possibility of any change in this regard. The combined output of the three properties amounts to above 300,000,000 lb. per year. This total is to be increased rapidly by 100,000,000 or more from the Chuquicamata mine of the Chile Copper Company, which with other metal controlled by the Guggenheims, will give that group the leading position among the world's copper merchants. At present the Guggenheim companies control about 30,000 tons of copper per month. As was announced in the Magazine last month, arrangements have been made for more direct marketing of this metal both in London and New York, though the alarm at first felt by metal merchants has somewhat subsided, as the companies have no revolutionary plans for immediately upsetting the markets.

CERRO DE PASCO.—The success of the Kennecott flotation and the passing of some important figures of the last generation has brought some changes in copperdom. The late J. B. Haggin and his associates, including D. O. Mills, Sr., H. McK. Twombly, and the elder Morgan, were all rather strongly opposed to anything like public participation in their individual ventures. All of the gentlemen named have been gathered to their fathers and close corporations are no longer so much in favour.

It is therefore in order that the public should be invited to participate in Cerro de Pasco. This property was always looked upon as the private enterprise of Mr. Haggin, at whose instance the millions spent in development were poured into the property. Now the controlling interests in the property are issuing to themselves securities to cover expenditures made, and these are being sold to the public on a basis that will allow the inside interests to retain a fair share of their holdings. Like the Kennecott, the Cerro de Pasco's new stock issue is without par value, which is the new and popular as well as logical method of capitalization of a mining enterprise. The new company has sold $10,000,000 in convertible bonds to J. P. Morgan & Co., the proceeds of this sale going to former owners as part of the purchase price of the properties; 666,666 shares of stock, without par value, are also given to the former owners in completion of payment. These shares have a present market value around $40 and are convertible on a basis of $30 per share, that is to say for each $1000 bond the holder may acquire $33\frac{1}{3}$ shares of stock. This conversion privilege does not accrue to the bondholders until two years from November 1, 1915. On this basis, however, the purchase price of the property to the new company would be something like $30,000,000, or, on the present market price, about $38,000,000, which may be taken to cover all previous expenditures and a fair vendor's profit.

The copper metal market at the moment (November 23) is buoyant, with good demand at 20 cents per lb., and it is to be anticipated that the mining industry will come in for a marked revival of activity and public interest.

TORONTO.

PORCUPINE. — The gold-mining industry continues active, with a steadily increasing output. The Dome Mines made a new high record for the month of October, with a production of $150,500 from 28,750 tons of ore, being a yield of $5·24 per ton. The previous high record for May 1913, was $148,499. The new 5-compartment shaft, which is being sunk vertically and will be the main working shaft, is down 50 ft. The 4-weekly statement of the Hollinger for the period ended October 7 shows gross profits of $158,342, from the treatment of 27,029 tons of ore, being a yield of $9·66 per ton, with working costs per ton of $3·19. In addition the mill treated 10,990 tons of ore from the Acme mine. Three distinct orebodies respectively 10, 6, and 4 ft. wide have been cut at the 425-ft. level, and carry about $10 to the ton. These veins were discovered by diamond-drilling over a year ago, and encouraged the management to undertake extensive development plans. The winding engine to be installed at the central shaft will be the largest in Northern Ontario, having a capacity of 5000 tons. Some important discoveries of new veins have been made at the McIntyre. At the 600-ft. level from No. 5 shaft, a mineralized belt 15 ft. wide has been found, with a rich paystreak $3\frac{1}{2}$ ft. wide in the centre. Another 5 ft. vein has been cut on the same level. At the Schumacher the shaft has reached the 600-ft. level, where a station has been cut. The mill is now producing about $25,000 per month. The Plenaurum property is being sampled by the officials of the La Rose Consolidated, who are negotiating for its purchase. The shareholders of the McIntyre have ratified the deal made by the directors for the purchase of the Jupiter.

KIRKLAND LAKE.—The mill and mine of the Tough Oakes are now run with electric power and development has been fully resumed. The output during the past year has amounted to more than $400,000. A group of 10 claims belonging to the Kirkland Lake Gold Mines, Ltd., comprising 360 acres, has been purchased by the Beaver Consolidated of Cobalt. The La Belle Kirkland, in the Goodfish Lake section, is being developed with highly encouraging results. A vein showing only a trace of gold on the surface has widened to 25 ft. at a depth of 100 ft. and is yielding rich ore. Machinery is being installed. Five promising veins are being opened up. The Dominion Reduction Co. has abandoned its options on several claims in the Goodfish Lake area. The Montana and Hecla Mining Co. has purchased claims in this district and will test them by diamond-drilling.

BOSTON CREEK.—Great interest in this new goldfield has been excited by a rich discovery on the McConnell-McDonough location in Pacaud Township, where a vein from 6 to 18 in. wide on the surface shows spectacular gold. A Detroit syndicate headed by George C. Miller has secured control of the property and will begin development immediately. The Rapp Mining, Development and Prospecting Co., which holds 27 claims in this locality, including that on which the original discovery was made, has a shaft down 85 ft. on an 8 ft. vein carrying free gold and has ordered machinery. The Dominion Reduction Co. is developing three claims and has sunk test-pits 30 ft. on two veins with satisfactory results.

COBALT.—The increase in the price of silver has latterly given a stimulus to mining operations, though shipments continue small. Many companies are still curtailing active production and are devoting their attention to putting underground workings in better order for increased production, when conditions show further improvement. Several companies are increasing their staffs and pushing development work, and some important discoveries have been made. At the Cobalt Comet, formerly the Drummond, which was taken over by the Kerr Lake in July, a niccolite and smaltite vein has been found by trenching, carrying about 400 oz. to the ton. This vein on being followed was found to contain shoots of plate silver. The Mercer Mining Co., which is working the old Gould leasehold of the Peterson Lake, has struck good ore in a rise from the 200-ft. level. E. P. Earle, president of the Nipissing, states that the vein recently discovered in the Cobalt Lake fault is the most important find made by the company in the past two years. It is from 8 to 10 in. wide and carries about 1800 oz. of silver per ton. The Shamrock, adjoining the Beaver, has cut a vein showing 1500 oz. to the ton. The shaft at the Beaver is now down 1230 ft., being considerably the deepest shaft in the district and will be put down farther until the contact with the diabase is reached. A station is being cut at 1200 ft. The Chambers-Ferland has found a new vein in a winze near the Nipissing boundary line and is taking high-grade ore from the 400-ft. level. The Timiskaming has declared a 3% interim dividend and will increase its mill capacity by 30 stamps. The La Rose Consolidated surplus shows a decrease on October 1. It had in cash $877,075, and ore in transit and at smelters to the value of $66,783, a total of $943,858, as compared with $1,396,619 in October 1914. The Mining Corporation of Canada, controlling the Cobalt Lake, Cobalt Townsite, and City of Cobalt mines, has discharged all alien enemy employees in accordance with orders received from the head office in England. The order affects about 50 men, mostly Austrians.

CONSOLIDATED MINING AND SMELTING CO.—A circular issued to shareholders, announcing the issue of a new block of stock, states that there has been a remarkable expansion in the company's productive capacity. The zinc output for 1916 has been ordered by the Canadian Shell Committee at profitable prices. The committee has also requested the company to undertake the refining of copper, which will at first be conducted on a limited scale, but is expected to develop and involve the treatment of much of the matte and blister copper produced by British Columbia mines. The output of refined copper during 1916 will be taken by the Shell Committee at fair prices. The capacity of the lead furnace has been taxed to the utmost to supply the demand during the past year and the output is sold for about six months ahead. When plans now being carried out are completed, the lead capacity will have been increased by 60% and put on a more economical basis.

PERSONAL.

J. A. AGNEW has gone to Colorado to visit the Camp Bird mines.

W. M. ARCHIBALD has been appointed manager for the Consolidated Mining & Smelting Co. of Canada, at Trail, British Columbia.

CHARLES A. BANKS, manager of the Jewel-Denero mines, British Columbia, is at present in London.

C. P. BERNARD has returned from Greenland and is going to the Congo.

C. A. BOLTON, secretary of the Chamber of Mines of Western Australia, is attached to the Australian Headquarters Staff in London.

R. G. CASEY, chairman of the Mount Morgan, is on his way back to Australia.

J. PARKE CHANNING has recently visited Oatman, the new gold-mining district in Arizona.

F. H. P. CRESWELL has joined the Union Expeditionary Force to German East Africa and holds the rank of major.

F. W. TEAGUE CURNOE is here from West Africa on a short visit.

DAVID CURRIE has returned from the Malay Peninsula.

W. R. FELDTMANN has returned from West Africa after having made his usual examination of the mines of the Ashanti Goldfields.

T. FURUKAWA, the head of the company which owns the Ashio and other important mines in Japan, was created a peer in connection with the coronation ceremonies last month. The new Baron is the third of his house and is well known in London and New York, where he once resided as a student at Columbia University.

A. F. GERNET, of Petrograd, is on a short visit to London.

J. W. GREGORY, professor of geology in Glasgow University, has been giving evidence for the Globe & Phœnix.

PHILIP GRIMLEY has returned from Northern Nigeria.

F. H. HAMILTON is in Canada.

R. W. HANNAM, major in the Local Forces, has returned to England from Uganda on sick leave.

F. W. HARBORD has been awarded the Bessemer medal by the Iron & Steel Institute.

HARLEY E. HOOPER has left the Junction North mine, at Broken Hill, and has joined the staff of Radcliffe & Co., at Tavoy, Burma.

H. C. HOOVER returned from New York, and has since been in Belgium.

BERTRAM HUNT has left for Colombia.

J. J. HUNTER, manager for the Champion (Nigeria) Tin Fields, is in London.

T. J. JONES is in London from Petrograd.

F. F. KETT has been in London, from Atbasar.

A. F. KUEHN is going to Burma at the end of this month to make an examination of the Bawdwin mine for the Burma Corporation.

C. F. H. LESLIE is confined to his home by influenza.

D. P. MACDONALD, lecturer in geology in the South African School of Mines, is in London as a witness for the Globe & Phoenix in the extralateral rights case.

G. MACFARLANE has returned to London from the Mawchi mines.

J. H. MEANS has gone to the United States.

EDWARD T. MCCARTHY has returned from Siberia after one of his periodical visits to Spassky, Atbasar, and other properties.

WILLIAM MOSES has retired from the position of Inspector of Mines in the Transvaal after 15 years service. In earlier years he was a coal-mining engineer in the north of England, and later with the De Beers company.

H. E. NICHOLLS, manager for the Jos Tin Area (Nigeria) company, is expected in London.

HENRY M. PAYNE has been in London from the Lena goldfields and has returned to Petrograd.

WALTER G. PERKINS has returned from America.

LAURENCE PITBLADO has returned to England from Chile.

C. W. PURINGTON has returned to London from Siberia on the conclusion of the summer campaign at the Lena goldfields.

ROBERT M. RAYMOND, managing director in Mexico for the El Oro Mining & Railway Co., has been in London.

J. HENRY RICKARD sailed on December 11 on his way to San Francisco to take the position of chief metallurgist to the Chapman Smelting Company.

L. D. RICKETTS has been nominated as the next president of the American Institute of Mining Engineers.

H. M. RIDGE has moved his office from 62 London Wall, to 2 Great Winchester Street, London, E.C.

HEINRICH RIES is lecturing on economic geology at Columbia University during the absence of Professor J. F. Kemp.

WILLIAM SELKIRK has moved his office from 3 London Wall Buildings to Pinner's Hall, London, E.C.

A. L. SIMON continues as manager of the Vagliano anthracite mines, South Russia.

W. E. SIMPSON is here from Toluca, Mexico, having arrived by way of New York.

S. J. SPEAK is returning from South Africa and expects to arrive home about December 20.

F. O. STEPHENSON, London manager of the mining department of Head, Wrightson & Co., has received a commission in the Royal Engineers.

NORMAN C. STINES, manager of the Sissert, passed through London on his way to San Francisco.

RALPH STOKES has received his captaincy in the Royal Engineers (Tunnelling) Company 174.

E. P. CORBETT SULLIVAN has received a commission with the Army Ordnance Corps.

ALFRED TELLAM is on his way to the Riddersk mines of the Irtysh Corporation, Siberia.

H. L. TEMPLER has received an appointment as captain in the Army Service Corps, and is employed in connection with mechanical transport work.

C. V THOMAS has joined the board of the Rayfield (Nigeria) Tin Fields, Ltd.

SCOTT TURNER is in London, having returned from the Spitzbergen coalfields after the conclusion of the summer season.

H. L. TWITE has been killed at the front in France, during mining operations.

W. R. VAN LIEW has returned to the mine of the Caucasus Copper Co. from America.

E. C. VIGEON is here from West Norfolk, Virginia.

JOHN SWAN WATKINS is manager of the mines of the Ashanti Goldfields Corporation.

F. C. WEST is general manager of the Mount Carbine wolfram mines, North Queensland.

RICHARD WILLIAMS is manager of the Edna May Central gold mine, Westonia, West Australia.

R. B. WATSON, manager of the Nipissing mine, Cobalt, recently visited the newly discovered gold deposits at Le Pas, Manitoba.

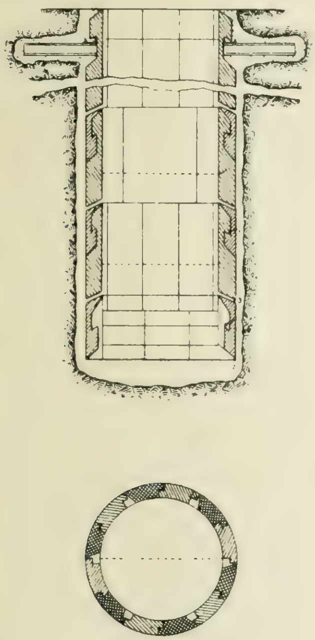
ERNEST WILLIAMS has left for South America.

SHIGEMA YAMANUCHI is in London this month.

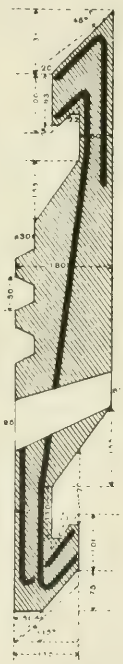
PRECIS OF TECHNOLOGY

[Copies of the original papers and articles mentioned under this heading can be obtained on application to the Technical Bookshop, Salisbury House, London, E.C., the book department of The Mining Magazine.]

Concrete Lining for Shafts.—At the August meeting of the Mining Institute of Scotland, Marcel Gillieux read a paper describing a new method of lining shafts with blocks of reinforced concrete. The blocks are made in Z-shape, in such a way that each ring can be suspended from that above, without bolts. In lining shafts sunk through wet ground, iron tubbing is usually employed, and brick or concrete linings have only been applicable where building can be done from the bottom upward. Concrete blocks may be substituted for iron tubbing, but the ties holding the



VERTICAL AND CROSS SECTIONS OF LINING.



ENLARGED SECTION OF CONCRETE BLOCK.

blocks together by means of bolts and nuts are difficult to adjust, and the weight of the blocks is apt to open the joints between each ring. The author has devised a special form of concrete block that interlocks and requires no bolts or ties. The illustrations herewith give a section of the complete shaft lining and a section of an individual block. A crown-ring is let into the rock at the top of the shaft, and after sinking has progressed sufficiently, the Z blocks are placed in the manner shown. When a sufficient number of rings are thus put in place, cement grout is passed through the openings in the blocks. The author describes the method of making the blocks. The cross-section sufficiently indicates the position of the reinforcing steel rods. A description is given of the method of making the vertical sides of the blocks so as to form close-fitting joints, and also of the method of lowering them into place.

Morley Martin Concentrator. — Much has been heard recently in Cornwall of a concentrator, intended particularly for the treatment of slime tin ores, invented by W. Morley Martin, of Redruth. We hope to publish within a short time an account of the table and the results obtained. In the meantime the inventor's claims may be ascertained by reference to British patents 15,442 of 1914, and 2844 and 2845 of 1915. In the first named patent the inventor states that the surfaces of concentrating apparatus at present used, of the type to which the patent refers, do not afford sufficient hindrance to the flow down them of the heaviest particles. To provide such hindrance he covers the tables with sheets of glass having frosted or fluted surfaces. The frosting is produced by sand-blast, but as glass with varying grades of frosting and number and depth of fluting are standard commercial articles, preparation of the surfaces on the spot is not necessary. The finer the surface the finer is the material that can be treated upon it. The surface best adapted to conditions can easily be ascertained by experiment. The inventor also describes the application of tables of this nature to the rough-dressing of coarse tailing, whereby a material can be obtained that will pay for re-grinding and re-concentration. The claims to the application of flutings is confined to their use on stationary tables or tables that move slowly in one direction. The employment of fluted glass in not in itself novel, but the apparatus in which it has been used received a reciprocating motion in the direction of the fluting. Such applications are excluded from the present patent. In the statement of claims, the inventor claims not only frosted or fluted glass, but all other substances with surfaces prepared in the same way. The two main claims are as follows: "(1) Apparatus for concentrating ores or the like in which the acting surface consists of frosted or frosted fluted glass substantially as described. (2) Apparatus for concentrating ores or the like in which the ore and water flow over a stationary or continuously moving acting surface consisting of a material which causes little hindrance to the movement of the larger particles but is provided with regular flutings or frosted flutings adapted to cause great hindrance to the smaller particles substantially as described." Patent 2844 of 1915 describes the method of mounting glass on a circular round revolving frame table with the flutings at right angles to the flow of the pulp down the inclined surface. This is the structure of table actually in use in Cornwall. The patent also describes the use of frosted glass with wider flutings or ribs ⅛ in. deep and ¾ in. apart.

Molybdenite in British Columbia.—The November *Bulletin* of the Canadian Mining Institute contains a paper by Charles Drysdale on the occurrences of molybdenite in British Columbia, describing more particularly the Molly mine in Lost Creek, near Salmo. The deposit was discovered in 1913, and the development of the property is in the hands of a Vancouver syndicate. Several car-loads have been sent to Denver, Colorado. Altogether about 50 tons of picked ore averaging 12 to 16% MoS_2 has been shipped, and there are several thousand tons of concentrating ore averaging 4% MoS_2 on the dumps. The molybdenite is found round the edges of granite which is intrusive into schists and limestones of Carboniferous age. The outer 6 ft. or so of the granite (the chilled border) is a fine-grained aplitic variety, and it contains a few scattered molybdenite grains. Within this capping is a zone of 10 ft. of granite characterized by platy or sheeted jointing, the joint planes being closely interlocked and lying more or less parallel to the capping. The molybdenite lies along these joint planes in reticulating veinlets, branching and crossing from joint to joint, and also impregnating the granite between the joint planes. The main granite body within this zone is diagonally jointed and much of it contains sufficient molybdenite to be milled profitably. Pyrite and pyrrhotite are found associated. On the weathered surface the pink hydrous molybdate of iron serves as an indicator for prospectors.

Mining Costs.—The *Columbia School of Mines Quarterly* for April (recently received) contains a report of a lecture given to the mining students by J. R. Finlay on the basic principles of mining cost. The lecture contains many remarks on the economic problems connected with mining that will be of use to others besides the college students, so we make quotations herewith. The cost of operating a mine can be divided into at least three independent items: (1) labour, (2) power, (3) supplies. The relative importance of these three items varies widely according to circumstances. For instance, the conditions in Western Pennsylvania are ideal under all three headings. A fertile country provides sustenance for a big industrial population, so that labour is plentiful and comparatively cheap. The coal mines provide the source of ample power, and the iron works and the machine shops afford the necessary resources in the way of plant and supplies. As a contrast, the conditions in Alaska and Nevada present an entirely different problem. Labour has to be imported and taken without discrimination, food is scarce and dear, and the amenities of life are absent. Higher wages have to be paid in order to attract labour, in face of the natural disadvantages. The cost of power is increased by the necessity of importing coal, though in a few cases local wood may supply the immediate needs, and occasionally a rich corporation may be able to erect a hydro-electric installation. The price of dynamite, tools, and other supplies to these outer regions is greatly increased by the cost of railway transport. Mr. Finlay quotes a contrast that has come within his own experience between costs in Southeast Missouri and Nevada. In both cases the output of ore was about 4 tons per man per day. At the mine in Missouri, the cost of labour was $2·60 per man per day, or 65 cents per ton; power, with coal at $2·25 per ton, cost 25 cents per ton of ore; and supplies cost 15 cents per ton of ore; total $1·05 per ton of ore. At the mine in Nevada, the cost of labour was $4·00 per man per day, so the cost of labour per ton of ore was $1·00; the cost of power, with coal at $6·75 per ton, was 75 cents per ton of ore; and the cost of supplies 18 cents per ton of ore; total $1·93 per ton, or 88 cents more than in Missouri.

In comparing mines, the physical and geological characteristics of the ore deposits have to be considered. Mr. Finlay quotes his experience in reporting on a silver mine in New Mexico, where the mining cost was as high as $8·00 per ton owing to the nature of the deposits. His clients were residents in the Lake Superior district, who, reasoning from local experience, considered that the cost per ton should not be more than $3·00. They did not accept his report, and on their own responsibility proceeded to capitalize and equip the mine on the basis of $3·00 costs. They are now sorry that they did so. Mr. Finlay proceeds to quote Hamilton Smith's dictum, pronounced 30 years ago, suggesting the advantage of comparing mines on the basis of yield per unit of stoping area. Hamilton Smith gave it as his opinion that, with gold ore of good quality, no mine would be profitable that yielded less than $3 per square foot of stoping area, equivalent to $130,000 per acre. Applying this formula recently to a fairly profitable gold mine in Nevada, having a vein 1 ft. thick of ore averaging $40 per ton, Mr. Finlay observed, allowing 13 cu. ft. per ton, that the yield of that mine was almost exactly $3 per square foot of stoping area. The actual stoping width was about 4 ft., and the profits were about 20% of the gross yield.

Mr. Finlay proceeded to say that some people are inclined to attach too much importance to cost-per-ton, as though this unit possessed some sacred function. It may often happen that some other unit, such as Hamilton Smith's yield per unit of stoping area, is more serviceable and relevant. Cost-per-ton is merely the value of the work that has been done on that ton, and may bear a very indefinite relation to the profitableness of the operation. As an extreme case, 1 ton of gold, worth $600,000, might be mined for $450,000, or 75% of its value, yielding a profit of $150,000. A ton of silver, worth $15,000, is mined at Cobalt for $6000, or at $600 per ton of ore, assuming it to contain 10% silver; yet this would not be called expensive mining. At Grass Valley, California, it costs about $5 to mine and mill 1 ton of ore; at the Michigan copper mines it costs only $1·25; yet applying Hamilton Smith's unit, the cost per acre of stoping area is shown to be nearly alike in these two places, namely, $100,000 at Grass Valley and $70,000 to $120,000 in the copper country. In Southeast Missouri, the cost is almost exactly $100,000 per acre for mining and milling. Thus it is seen that the really important factor is not how many tons are mined, but how much area must be excavated.

Recovery of Zinc Oxide from Slag.—In *Metallurgical and Chemical Engineering* for November 1, H. B. Pulsifer describes the recovery of zinc oxide from old refinery slag that had accumulated at the National plant of the American Smelting & Refining Co. at South Chicago, Illinois. When this plant was dismantled early in 1915, B. F. Hedges and R. D. Divine, who had been superintendent and metallurgist at the refinery, undertook the treatment of the slag as a venture of their own, and they leased part of the plant. The zinc in the slag was not a constituent of ore, but was the part of the zinc added in the Parkes desilverization process that has to be subsequently removed from the desilverized lead in a refinery furnace. During 25 years operation 150,000 tons of slag had accumulated, averaging 10 to 15% zinc. The process now employed for treating this slag consists in adding limestone and coke, and smelting in a blast-furnace. The bullion blast-furnace, which had for long been used in a shortened condition, was lengthened from 5 to 9 jackets on a side, and it now measures 46 by 156 in. at the tuyeres. The crucible and curb were built up another foot so as to obtain more fall. The inside capacity of the crucible was largely filled in, and has since become entirely filled, so that the slag and lead flow out together into the small pot fore-hearth. From the settling pot the slag flows to a granulating tank. The furnace is run with hot top. Much experimental work on feeding resulted in the adoption of low hand feeding from one side only. The top of the charge is kept nearly at the level of the feed floor. The blast used is 12 oz. The capacity is about 65 tons per day. The recovery of zinc is about 50%, the granulated slag still containing about 5%. Clouds of white oxide of zinc come off with the burning gases. A fan draws the gases and fume through 700 ft. of steel flue, air being also drawn in so as to cool the gases to 200° F. Much of the fume settles in the flue, and the remainder is caught, after passing the fan, in Prinz & Rau dust collectors which automatically fill the fume into bags. The zinc oxide thus recovered, amounting to 3 tons per day, is sold to zinc smelters. In addition to this oxide, about a ton each of lead bullion and speiss, both silver-bearing, is obtained, making a noteworthy increase in the income. It will be remembered that in the Appalachian region flue dust from iron blast-furnaces is saved and sold to smelters for the zinc contained, and some years since J. A. Van Meter, while at the Bertha plant, used the oxide furnaces for burning low-grade material so as to effect a fire concentration preliminary to distilling for spelter.

Antimonial Gold Ores.—The *South African Mining Journal* for October 9 records the commencement of operations at the United Jack Company's mine near Leydsdorp in the Murchison Range, Eastern Transvaal, and briefly describes the process devised by John S. MacArthur for treating the antimonial gold ore. The average ore contains 7 to 8 dwt. gold and 12½% of antimony sulphide. It is crushed in two ball-mills to 30-mesh and delivered to six leaching vats each 23 ft. 9 in. diameter by 8 ft. deep, where it is treated with caustic soda solution. The sulphide is dissolved in the vats and the resulting solution is sent to carbonators to be acted on by carbonic acid derived from lime-kilns. By this reaction the sulphide is precipitated as a powder, which can be collected and sold for its antimony content. The leached ore is sent to the cyanide plant, where the gold is extracted. Mr. MacArthur developed the process some years ago, and it was proposed for adoption at the Cobar gold mine before that mine's absorption by the Great Cobar. The present economic position of antimony gives the process its chance.

Mexican Mine Taxes.—Under date of August 31, Carranza has issued a decree modifying that of March last as regards payment of pertenencia taxes. In effect it postpones until March 1, 1916, the taking of effect of the new law on this point, and provides for a scale of interim payments. The essential parts of the decree follows, translated from the Spanish text of the *Mexican Mining Journal* for October.

1. During the time herein specified the changes in the tax fixed in article 10 of the law of March 25, 1905, made by the decree of March 1, 1915, shall be modified as regards mines in the following particulars: (*a*) The tax shall be $6 (six pesos) annually for each pertenencia whatever may be the number of pertenencias, during the third of the year comprised from the months of July last to November of the present year. (*b*) The tax shall be $8 (eight pesos) annually for each pertenencia whatever may be the number of pertenencias, during the third of the year comprised from November first of the present year to the month of February 1916. (*c*) After the first of March 1916, the tax shall be as decreed on March 1, 1915.

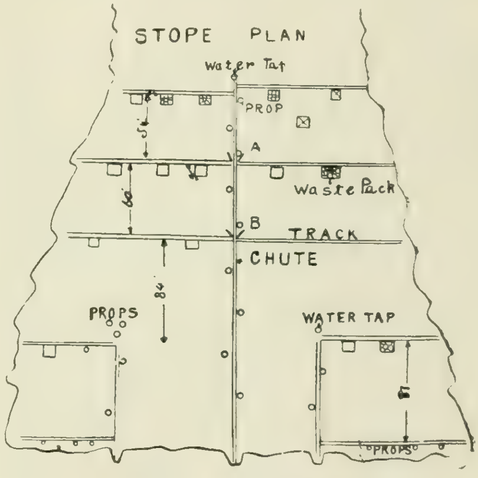
2. In the case of those pertenencias which were in arrears for taxes at the beginning of last July, there shall be conceded the payment of $6 (six pesos) per annum for each one of the first twenty-five pertenencias and $3 (three pesos) for each one in excess.

3. All those mine proprietors who have paid for the third of the year which began with July last shall be refunded the excess after deducting payments conformable to the present decree.

4. Time until September 30, 1915, is extended for payment, without penalty, of all taxes fixed by the present decree.

Payment under this decree, as under that of March last, is required in gold or its equivalent in silver. We discussed this matter at length editorially in our November issue.

Removing Broken Ore from Stopes.—The September *Journal* of the Chemical, Metallurgical, & Mining Society of South Africa contains a paper by M. Weinbren describing the method of removing broken ore from the stopes, employed at the Robinson Deep mine. At this mine the dip of the lode is from 25° to 33°, and the problem of carrying the broken ore to the shaft or to the main level or haulage road when the lode lies at these angles presents well known difficulties. The method described by Mr. Weinbren is not new, and many of our readers could quote similar experience, but as a specimen of individual practice it deserves record. With stopes at this slope, the difficulty with the shovellers is that they like merely to pass the ore down the foot-wall for the other shovellers to move in similar fashion. Thus many more men are employed than is actually necessary. At the Robinson Deep this trouble is overcome by providing a line of chutes at a safe distance from the working faces, and a series of horizontal tram-lines from the



Stope Plan at Robinson Deep.
Showing method of removing broken ore.

faces to the chutes. The accompanying stope plan gives an idea of the system. The tram lines are about 50 ft. apart on the dip. Specially designed trucks are loaded by the shovellers near the faces, and these are pushed to the chutes, where the ore is dumped. A water flush at the top of the line of chutes serves to carry the ore down to the level below. The chutes are anchored to props by means of chains and bolts. The tram lines are laid on sleepers which rest at their upper ends on the foot-wall and at the lower ends on lagging supported on props. Wherever possible waste-packs are built from the foot-wall to support the tracks. Broken rock is shovelled between the sleepers and the lagging in order to strengthen the tram-line. It will be seen from the illustration that a central line of chutes will serve both stope-faces. At the lower part, when working has progressed, subsidiary chutes are inserted, one for each face. In the discussion following the reading of Mr. Weinbren's paper, G. Hildick Smith described a similar system that has been in use at Ferreira Deep for three years past. He mentioned that the chutes at the latter mine are made of steel plate bent to a shallow curve, with a central reinforcement made from the sides of worn chutes. In connection with Mr. Weinbren's paper, it is interesting to refer to E. M. Weston's paper in the *Engineering and Mining Journal* for October 23, describing another system for carrying broken ore down the foot-wall of lodes dipping at this angle, the method consisting of the use of barrows, the wheels of which fit a monorail.

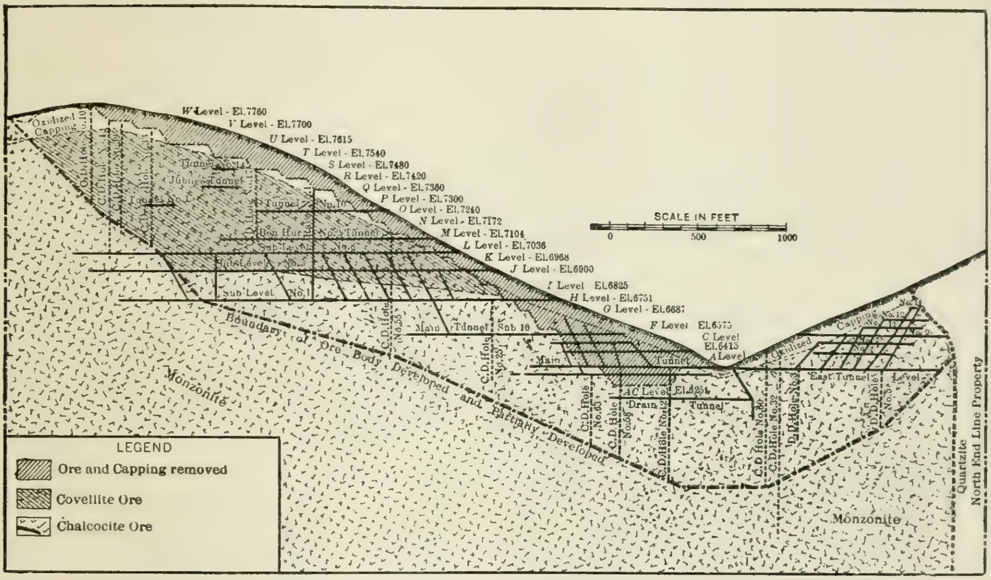
European Mining Finance.—In a paper prepared for the International Engineering Congress, held at San Francisco in September, J. L. Gallard presents some general notes based upon his experience as mining editor of *The Financial Times*. He calls attention to the large proportion of the mines of the world that are controlled from Europe and especially from London, but indicates that general participation in mining finance in London did not come until the development of the Rand called at once for large capital and gave an assurance of stability not previously common in mining ventures offered to the public. Between 1893 and 1902 inclusive, 5482 mining companies calling for £582,915,449 were registered in London. Of these, 4532, with capital amounting to £526,680,823, were formed for operations abroad. In 1895, 150 companies calling for £18,250,000 were formed for operating in South Africa, though most of the Rand companies are registered in the Transvaal. In 1895 and 1896 Western Australian mines formed the motive for the formation of 700 companies with an aggregate capital of £72,000,000. Gathering and investing such sums of money have led to the development of a complex system in which the London Stock Exchange plays a large part. In general the mines are introduced by financing syndicates and development companies. If shares are offered to the public a prospectus must be issued and the directors are individually liable for the truth of the representations made therein. Shares may, however, be introduced upon the Stock Exchange by brokers without prospectus, though in such cases it is customary to circulate unsigned reports "for information only." There has been a great and welcome change in recent years in the character and extent of the information made public and "a company is not cold-shouldered because its directorate does not include a duke, a marquis, a lord, or a baronet." Mining engineers are more commonly found in the directorates, and 'technical committees' are in style. The vendor's statements must be checked by the report of an independent engineer, and fine phrases, while not entirely absent, are less potent than in old days. Mr. Gallard notes the growing disposition to finance by means of debentures and explains the use of options and other devices of finance. He believes that heavy demands will still be made on the London market. The German mines are largely state owned, the way to the French investors pocket book is well guarded and beset with many technical difficulties, and the need of capital for mining development continues insistent. He quotes R. N. Kotze's estimate that only half the ore on the Rand has been developed and that the remaining capital requirements will total £50,000,000, and he points to the needs of the rapidly expanding Russian mining industry, as indicating what may be anticipated at the end of the war.

Viscosity of Oils in Relation to Flow through Pipes.—This little understood subject was discussed at the November meeting of the Institution of Petroleum Technologists by R. T. Glazebrook, director of the National Physical Laboratory, who presented results of tests made for the Admiralty by Messrs. W. F. Higgins and J. R. Pannell. The purpose of the tests was to determine if possible the laws of flow with a view of determining how far the pressure difference could be calculated when the viscosity of the oil and the size of the pipe were known. The tests were made with Mexican petroleum and the results were most interesting. It was proved that the ordinary laws of viscous flow hold so long as the velocity of flow is less than a certain 'critical velocity,' to calculate which a formula is given. With Scotch shale oil, for example, at 60°F., this critical case occurs at a speed of 1 ft. per second in a 4-in. pipe, and the flow becomes eddying or turbulent for higher speeds up to 3½ ft. per second, the maximum observed. The experiments tended to show that the relations which hold for the flow of oil in pipe are the same as for the flow of any other viscous fluid. Up to the critical point, and all the oils tested kept below that except the Scotch shale oil as noted at the higher temperature, the flow is stream-line in character. In the course of these tests, interesting studies were made covering various other features of oils. It was determined that the flash point could be varied to the extent of a few degrees by varying the quantity tested, but that the difference is not sufficiently great to necessitate a change of the test. Mixtures of oils were tested, and it was found that the density of the mixture is proportional to the quantity and density of the constituent oils. Apparently there is no simple law connecting the viscosity of a mixture with that of its constituents, but the addition of a low-viscosity oil to one of high viscosity produces a greater decrease of viscosity than would be demanded by the simple law of proportion. While some tendency toward separation was observed in the case of mixed oils stored together, the amount was comparatively small, and not such as to require special precautions being taken in practice. It was also determined that the Mexican oils will not yield sufficient vapour to flash at less than 140°F., corresponding to 145° on the Gray apparatus. It was further learned that the viscosity of Mexican oil changes with time, and at low temperature tends to increase. The normal value may, however, be restored by a short exposure to higher temperature. Mexican oil was the only one of those tested that showed this characteristic, and the extent of the effect, even with Mexican oil, can be greatly reduced by adding a low-viscosity oil, for example, 10% of Scotch shale oil.

Disseminated Copper Ores of Bingham Canyon, Utah.—In the *Bulletin* of the American Institute of Mining Engineers for November, J. J. Beeson presents the first detailed account made public of the character and origin of the ores that are worked by the Utah Copper Co. J. M. Boutwell's studies of Bingham were made before the 'porphyry' copper ore had become dominant, and since his monograph appeared only brief articles have been printed. Mr. Beeson spent six months in underground sampling, followed by three months on the surface, in preparation for this study. The laboratory investigations were made by him at Stanford University, where he had the excellent advice and assistance of C. F. Tolman, A. F. Rogers, and S. W. Young, so his results may be accepted with confidence. He indicates the importance of the orebody by the following quotation from the guide-book issued in connection with the visit of the Institute to the mines in 1914:

"The orebody of the Utah Copper Co. consists of an altered silicious porphyry, containing small grains of copper minerals, very uniformly disseminated throughout the mass, both in fracture seams and in the body of the rock, averaging about 1·5% copper, 0·15 oz. silver, and 0·015 oz. gold. The total area of lode-mining claims in Bingham owned by the Utah

Copper Co. is 736 acres, within the boundaries of which development has shown that at least 225 acres contain mineralized porphyry of commercial value. The entire porphyry area has not yet been developed, and the maximum thickness of the orebody in the 225 acres has not been fully demonstrated, but the existing development in this area shows now an average thickness of 445 ft., which is equivalent to about 1,500,000 tons of ore per acre, or a total of about 361,220,000 tons. In making the calculations to determine the tonnage of ore and its average assay, 50,761 assays were used, representing 23,465 ft. of diamond-drill and churn-drill holes, 285,913 ft. of drifts, rises, and winzes, and 7130 linear feet of steam-shovel cuts, or a total of 316,508 linear feet of development work. The orebody, as at present developed, has a maximum length of a little over one mile and a maximum width of more than half a mile. Further development of the property will add materially to its ore reserves."



LONGITUDINAL SECTION THROUGH CENTRAL PORTION OF THE OREBODY OF THE UTAH COPPER CO.

The general relations of the orebody and mine workings to the topography, as well as those of the capping to the covellite and chalcocite ores, are shown in the accompanying cross-section. It is to be remembered that while the ore is now won by steam-shovel mining, extensive underground workings exist, having been developed both for mining and for exploratory purposes.

The orebody is considered to have been formed by a primary mineralization under conditions of high temperature in two periods, forming an early and a late hydrothermal period, followed by a secondary enrichment, which gave rise to the covellite and chalcocite ores that are actually mined. Mr. Beeson presents his results backed by a mass of detail and illustrated by numerous photomicrographs and sketches that cannot be easily reproduced or adequately summarized here. The monzonite contains more than the usual amount of magnetite, which is believed to be of late magmatic origin, and to replace the earlier formed biotite. The latter has also been in part replaced by sulphides during the early hydrothermal period following consolidation of the mass. This period was most important, as it effected a comparatively uniform dissemination of chalcopyrite and pyrite through an area more than a mile long and half a mile wide. It extended to a depth of at least 2500 ft. It is believed that the magnetite was the precipitating agent for the sulphides.

The secondary enrichment was controlled by three factors: *(a)* intense fracturing which afforded channels for uniform circulation of the waters; *(b)* sericitization which had increased the porosity and hence the permeability of the rock; *(c)* erosion which has taken place more rapidly than oxidation, the steep slopes shedding water normally precipitated, and only allowing that from melting snow or extra heavy rains to soak into the rock. In recent times the altitude has resulted in cold winters and warm summers, which influenced the rate of oxidation. The greatest depth to which enrichment extends is 800 ft. below cover. The average thickness of the known orebody is 445 ft., and of the capping 114 ft. There are two types of enrichment according as covellite or chalcocite dominates. The covellite body lies above and higher up the slopes than the chalcocite ore. Observations show that during the warm dry summer months, when the rock is moistened only by an occasional shower, oxidation is rapid and the iron and copper sulphates, together with sulphuric acid, accumulate just below the leached capping. The water of the first heavy precipitation dissolves the accumulated salts, producing a more concentrated solution than those which follow. In this and other ways periodic variation in character and concentration of the percolating waters is produced. Just below the capping the sulphuric acid probably reacts with the sulphides to produce hydrogen sulphide, which in turn reduces ferric to ferrous sulphate. Part of the hydrogen sulphide passes on downward with the sulphate solution carrying with it small amounts of colloidal copper and iron sulphide. The copper sulphate, reacting with chalcopyrite, produces covellite and ferrous sulphate. Covellite also replaces other sulphides present, though the reactions are more complex. The solutions were slightly acid to neutral. In the pit and under the lower slopes chalcocite is dominant and carbonates are present. It is believed that carbon dioxide, from decaying vegetation on the upper slopes, afforded the necessary supply of carbon. The solutions here were slightly acid to alkaline. The whole process then involves the development of primary pyrite, chalcopyrite, and possibly bornite, by hydrothermal waters, from magnetite deposited by magmatic waters, with a later enrichment by surface waters which produced covellite under acid conditions and carbonates and chalcocite where the solutions were alkaline or nearly alkaline. Secondary chalcopyrite and bornite in part were also found representing intermediate steps, and an important factor was the concentration of ferrous sulphate in the enriching solutions.

Plating with Cobalt.—Under the auspices of the Canadian Department of Mines, researches have been conducted at Queen's University, Kingston, Ontario, in connection with the practical applications of cobalt. This subject is a matter of public interest, seeing that the large amounts of cobalt contained in the silver ores mined at Cobalt, Ontario, are in little or no commercial demand. The third report issued in connection with these researches deals with plating with cobalt. An extensive series of experiments with varying solutions and conditions of deposition were conducted by H. T. Kalmus, C. H. Harper, and W. L. Savell, who had the benefit of the practical advice and opinion of Walter S. Barrows, a foreman electroplater at a motor-car works. We give herewith a summary of their results and recommendations. In particular two solutions were found to be suitable for commercial application. The first consists of cobalt ammonium sulphate, $CoSO_4,(NH_4)_2SO_4,6H_2O$, 200 grammes to the litre of water; and the second a mixture of 312 grammes cobalt sulphate $CoSO_4$, 19·6 grammes sodium chloride, to 1 litre of water, with boric acid added nearly to saturation. Deposits from these solutions, on brass, iron, steel, copper, tin, German silver, lead, and Britannia metal articles, of different shapes and sizes, formed under conditions identical with those in general nickel-plating practice, are firm, adherent, hard, and uniform. They may readily be buffed to a satisfactorily finished surface, having a beautiful lustre, which, although brilliantly white, possesses a slightly bluish cast. The electrical conductivity of the solutions is considerably higher than that of the standard commercial nickel solutions, so that, other things being equal, they may be operated at a lower voltage for a given speed of plating. Solution No. 1 is capable of depositing cobalt at a speed at least four times that of the fastest satisfactory nickel solutions, and No. 2 solution at a speed at least fifteen times as great. Plates from both of these solutions satisfactorily withstood the various bending, hammering, and burnishing tests to which commercial nickel work is ordinarily submitted. The solutions are remarkable for their satisfactory throwing power. That is, they readily and satisfactorily deposit the cobalt in the indentations of the work. They operate at high speeds in a perfectly still solution without agitation of any kind. They are cleaner, that is, free from creeping salts and precipitated matter, than the standard commercial nickel baths.

The cobalt deposited is much harder than the nickel deposited in any commercial nickel bath. Consequently a less weight of this hard cobalt deposit will offer the same protective coat as a greater weight of the softer nickel deposit. With solution No. 2, operating at 150 amperes per square foot, a sufficient weight of cobalt to stand the usual commercial tests, including buffing and finishing, is deposited in one minute. With the best nickel baths it takes one hour, at about 10 amperes per square foot, to deposit a plate equally satisfactory. Therefore, the actual weight of metal on the cobalt plate must be approximately one quarter that of the nickel. For many purposes, under the conditions of these rapid plating solutions, one fourth the weight of cobalt, as compared with nickel, is required to do the same protective work. Consequently, if nickel is worth 50 cents per pound, in the anode form, cobalt at nearly $2 per pound would be on the same basis, weight for weight of metal. In addition there are other advantages of cobalt in saving of labour, time, etc.

Pre-Cambrian Rocks of Ontario.—The 1914 report of the Ontario Bureau of Mines prints a paper by Willet G. Miller and Cyril W. Knight on the metallogenetic epochs in the Pre-Cambrian of Ontario. This paper was read before the Royal Society of Canada, Section IV. The authors also have a paper in the *Journal of Geology* for October-November on the general geology of these rocks and describing their revision of the classification. We give herewith an outline of the paper dealing with the metallogenetic epochs. The importance of the ore deposits contained in these rocks, for instance those of nickel at Sudbury, cobalt-silver at Cobalt, and gold at Porcupine, developed during the last ten years or so, makes a closer classification than that of Lindgren desirable. The development of these ore deposits has afforded information on which a revised classification can be made. The following is Mr. Miller's classification, beginning with the youngest:

KEWEENAWAN. An epoch, following basic intrusions, of (1) silver, cobalt, nickel, and arsenic at Cobalt and elsewhere; and (2) nickel and copper at Sudbury, and copper elsewhere. Certain gold deposits, not now productive, appear to belong to this epoch.

ANIMIKEAN. An epoch of deposition of iron formation as a chemical precipitate.

ALGOMAN. An epoch, following granite intrusions, of gold at Porcupine and at many other localities, and of auriferous mispickel. Deposits of galena, blende, fluor-spar, and other minerals also appear to have been derived from the granites, but some of them were not formed until after Pre-Cambrian time. Preceding the intrusion of the Algoman granites, basic intrusives of post-Timiskamian age gave rise to nickel and titaniferous and non-titaniferous magnetite deposits and chromite.

TIMISKAMIAN. An epoch of minor deposition of iron formation as a chemical precipitate.

LAURENTIAN. Granite intrusions probably gave rise to ore deposits which have been removed by excessive erosion, as is known to be the case with deposits of later origin

LOGANIAN *(a) Grenville*. An epoch of extensive iron formation as a chemical precipitate among other sediments.

LOGANIAN *(b) Keewatin*. Composed largely of basic volcanic rocks.

From the above it will be seen that there were four great metallogenetic epochs, the Grenville, Algoman, Animikean, and Keweenawan. A fifth epoch representing orebodies associated with basic intrusives that preceded the Algoman granite and followed the Timiskamian sediments is not of so great importance, as the orebodies have been largely removed by erosion. It is also seen that there was an alternation of intrusion and sedimentation, and that the ore deposits followed igneous intrusions. Moreover the igneous intrusions were alternately acid and basic.

The basic rocks of the early Algoman age are of greater amount than usually recognized, being often wrongly classed as Keewatin. These basic rocks are represented by the sudburite of the Sudbury area, by the lamprophyres of Cobalt and elsewhere, and apparently by the basic rocks of Dundonald and Reaume townships associated with nickeliferous pyrrhotite and chromite. Iron formation occurs in three epochs, the Loganian, Animikean, and Timiskamian, but is of economic importance only in the first two. Certain deposits of titaniferous and non-titaniferous magnetites, not now being worked, are associated with basic intrusives that appear to be of pre-Algoman age. Arsenic occurs in two epochs, and has been produced in economic quantities from the rocks of both. As far as is known, gold occurs in economic quantity only in the Algoman, although small quantities are obtained in refining the copper-nickel ores, and certain auriferous quartz deposits, not now productive, appear to be genetically connected with Keweenawan intrusives. Nickel was deposited in economic quantities in two epochs. Cobalt, silver, and copper are produced only from deposits of Keweenawan age. Platinum, palladium, mercury, and other metals are found in small quantities with Keweenawan ores. Zinc and lead have been mined, but the age relations of some of the deposits are in doubt.

Metalliferous Mining in Hunan.—In the *Far Eastern Review* for September, A. S. Wheler gives details about the present condition of mining in this important interior province of China. It is an area long known to be rich both in the amount and variety of mineral wealth though, as primitive methods of mining and metallurgy have so far dominated operations, the output has had small part in the world's metal trades. An exception is in the case of antimony, for the province is the seat of operations of the Hua Chang company which, long an important producer of that metal, now occupies an especially prominent position in the trade. The Hua Chang company has an old monopoly of the deposits, which has been confirmed by the authorities of the Republic. It also owns the French patent rights for China for the Herrenschmidt furnace. Hunan ores are remarkably free from lead, copper, arsenic, and other impurities. The output for 1914 is given as, regulus, 2955 tons; crude (roughly 70% Sb.), 14,792 tons; ore, 8859 tons; ash (assaying as much as 30%), 2510 tons. The main works are at Changsha, the provincial capital, but there is also a recently-built refinery at Hankow. Antimony is found at many points in the provinces, and there are a number of local furnaces. The largest lead-zinc works in China, the Shui-ko-shan, is also in Hunan, being about 32 miles south of Hengchow. The works

Revised Geological Map of Ontario.

are run on modern lines by the Hunan Official Mining Board, and since 1896 have produced 50,000 tons of lead concentrate, and 126,000 tons of zinc concentrate. The ore, a mixed sulphide, occurs in limestone, and is treated by sorting, jigs, and Wilfley tables. Middling is being stored. In 1914, 56,000 tons of ore yielded 5000 tons of lead concentrate and 14,600 tons of zinc concentrate. The former assayed 70% lead, 8% zinc, and 30 to 40 oz. silver; the latter assayed 30% zinc with 5 to 10% lead. Mr. Wheler estimates the total cost per ton of concentrate at $13 (local currency) excluding depreciation and amortization. The concentrate is marketed through Carlowitz & Co. at Hankow, though an experimental smelting plant is in operation at Sungpo, with which point the mine is connected by light railway. Tin occurs, and is produced at several points in the southern part of the province near the Kwantung border. The works are small, and only native methods have as yet been introduced. Mercury is found in the western part and the immense waste dumps lend credence to the statements that the mines have been worked for centuries. The ore is disseminated through about 100 ft. of thickness of horizontal dolomite free from igneous intrusions so far as observed. The richer crude ore is sold to buyers from Tungzen and Kweichow, but the low-grade is treated in small local furnaces. Gold has been washed from river sands near Ping-kiang in northeastern Hunan, and the Official Mining Board is now conducting lode mining on a small scale. Sulphur is also produced, and the Hanyang Iron Works Co. mines manganese for smelting with its iron ore. It would seem that in this province there are deposits that might form the basis of a considerable mining industry.

TECHNICAL JOURNALS FOR THE MONTH

[*In this department will be listed each month the leading articles dealing with metal mining and non-ferrous metallurgy that appear in the principal technical journals, though no attempt will be made to mention every item in every publication, and titles are necessarily shortened. Articles of purely local interest are omitted. The purpose is to record the more important and interesting current papers. Those which have especial bearing upon technological matters are given further notice in the Précis, and are indicated by an asterisk *. Copies of any of those listed can be obtained through The Technical Bookshop, Salisbury House, London, E.C., the book department of The Mining Magazine*].

BRITISH.

Colliery Guardian.—*November 5:* Recent Developments in Mechanical Ventilation, James Keith (paper read before Institute of Marine Engineers). *November 12:* Compressed-air Haulage System at Bothwell Park Colliery, Scotland. *November 26:* 'Diamond' Coal-Cutting Machines, T. Campbell Futers.

The Engineer.—*November 12:* Aluminium Melting Furnace.

Engineering.—*November 19 and 26:* The Water Powers of Canada.

Institution of Electrical Engineers.—Manchester section meeting *November 16:* Production and Properties of Electrolytic Copper, B. Welbourn.

Institution of Mechanical Engineers.—*October 29:* Thomas Hawksley lecture, by Dugald Clerk, on the World's Supply of Fuel and Motive Power (to be printed in the December issue of the Institution's Journal). *November 19:* Effects of Molybdenum on Steel, J. O. Arnold and A. A. Read (the authors admitted that though the effect of molybdenum was powerful, reliable results were not always obtained).

Institution of Petroleum Technologists.—*November 16:* Viscosity of Oil in Relation to its Rate of Flow through Pipes*, R. T. Glazebrook, W. F. Higgins, and J. R. Pannell.

Iron and Coal Trades Review.—*November 12:* The Choice of Nickel-Chrome Steel, particularly for Working Parts of Automobiles, J. H. S. Dickenson. Classification of Manganese Ores, according to relative contents of iron and manganese, a paper giving analyses of many well known ores. *November 26:* Germany's Accumulation of Auxiliary Metals before the War, manganese, nickel, chromium, tungsten, antimony, aluminium.

Manchester Geological and Mining Society.—*November 9:* Structural Geology of South Lancashire Coalfield, George Hickling, Wheelton Hind, and A. Strahan.

COLONIAL.

Canadian Mining Institute Bulletin.—*November:* Testing Asbestos Mill Fibre, Edward Torrey; Ratio of Explosives to Coal Produced, F. W. Gray; Electric Furnace Steel in Canada; Geology of the Molly Molybdenite Mine*, C. W. Drysdale; Workmen's Compensation Laws, J. C. Reid.

Canadian Mining Journal.—*October 15:* Value of Research to Industry, F. M. Turner; Mining School of the Cleveland-Cliffs Iron Company, C. S. Stevenson; Heating as a Phase of Ore Treatment, F. L. Grammer; Water Powers of Labrador, J. W. McGrath. *November 1:* Mining in the Yukon, J. B. Tyrrell; Beaver Lake District, Saskatchewan and Manitoba, Wm. McInnis.

Chemical, Metallurgical, and Mining Society of South Africa.—*September:* Cyanide Consumption on the Rand, investigations as regards possible economy, H. A. White; Prevention of Hydrolysis in Cyanide Solutions, H. M. Leslie; Method of Removing Broken Ore from Stopes*, M. Weinbren.

Journal of Chamber of Mines of Western Australia.—*September 30:* Government Procedure in Suspected Gold Stealing Cases at Kalgoorlie; Extraction Methods at the Sons of Gwalia Mine, T. B. Stevens.

Mining and Engineering Review (Melbourne).—*October:* Steam-Electric Power Plant at the North Bulli Colliery, New South Wales, R. C. Cliff.

Queensland Government Mining Journal.—*October:* Annan River Tinfield, Cooktown District, North Queensland, E. C. Saint-Smith (Part 3, giving commercial and geological details of the various workings); Molybdenite in the Mount Perry District, a recent discovery, Lionel C. Ball; Tally-Ho Mine, Mackay District, containing lead, zinc, gold, and silver, W. E. Cameron.

South African Mining Journal.—*October 2:* Is Rand Mine Ventilation Inadequate, High Temperature a Cause of Slackness and Discontent; Possible Markets for South African Asbestos. *October 9:* MacArthur Caustic Soda Process at Antimony-Gold Mine in Murchison Range; Mining Prospects of Murchison Range District [continued in issues of October 23 and 30]. *October 16:* Mining Activity in Pilgrim's Rest District, a call for government aid to the small man; Miners' Phthisis and the Politicians. *October 23:* Gold Mines in Barberton and Pietersburg Districts and their Equipment. *October 30:* Comparative Costs of Compressed Air and Electricity for Use in Mine Stope Haulage, A. E. Middleton (from a paper read before the South African Institute of Electrical Engineers). *November 6:* Special Report of the Phthisis Prevention Committee, preliminary notice.

FOREIGN.

American Institute of Mining Engineers Bulletin.—*November:* Disseminated Copper Ores of Bingham Canyon, Utah*, J. J. Beeson; Illumination of Mines, R. P. Burrows; Evolution of Drilling Rigs, R. B. Woodworth.

Engineering Magazine.—*November:* Heavy Unloading Equipment, R. L. Streeter; Wrought Iron or Steel Pipes? quoting many tests to the effect that differences within each class are more important than those between wrought iron and steel pipe as classes, L. C. Wilson; Mechanical Stokers, describing more important modern types, C. C. Brinley.

Engineering and Mining Journal.—*November 6:* Silver Hill Underground Hoisting Station, James Humes; Acquiring Placer Mining Claims in British Columbia, J. A. Macdonald. *November 13:* Smelting at Panulcillo, Chile; Cost of Mine Opening, E. D. Gardner; Gennamari Mill, Sardinia, C. W. Wright. *November 20:* Metallurgy in the Cœur d'Alenes, H. A. Megraw; Motor Travel in Desert Company, L. H. Eddy; Speeding Up the Plane Table, R. T. Hancock; Cost of Sinking 900-ft. Shaft, H. A. Linke. *November 27:* Building the Tough Oakes Mill—I, J. A. Baker; Shrinkage Stoping, E. H. Dickenson and H. J. Volker; Annaconda's Community Experiment.

Far Eastern Review.—*September:* China's Company Regulations; Metalliferous Mines of Hunan Province*, A. S. Wheler; Gold Mining in Heilungkiang, notes establishment of a Chinese Government Gold Mining Department for Manchuria at Heiho, with guards, plans for roads, new workings, etc.

Journal of Geology.—*October-November:* Revision of Pre-Cambrian Classification in Ontario, with a section on the relative economic importance of various epochs, W. G. Miller and C. W. Knight.

Metallurgical and Chemical Engineering.—*November 1:* Zinc Oxide from Lead Blast Furnace Slag*, H. B. Pulsifer; Rapid Precise Standardization of Acid Solutions, M. Randall and C. C. Scalione; Thermal Principles of the Blast Furnace [continued *November 15*], J. E. Johnson, Jr.; Electrolytic Precipitation of Gold, Silver, and Copper from Cyanide Solutions [continued *November 15*], G. H. Clevenger; New Riffling for Concentrator Tables. *November 15:* Flotation of Joplin Galena Slime, Geo. Belchic and Glenn L. Allen; Electrolytic Antimony Refining, A. G. Betts.

Mexican Mining Journal.—*September:* Use of the Brunton in Mine Surveying, handy short cuts and important cautions, J. O. Greenan. *October* (in Spanish section): Decree Regarding Mining Taxes, dated August 31*.

Mining and Engineering World.—*October 30:* Glass Mine Models in Mine Work, Harold Lakes; Split Check Leasing System in Colorado; New Denver Electric Rock Drill, A. J. Hoskin; Materials Adapted for Lining Electric Furnaces, Olaf Peterson. *November 6:* Pulverized Coal for Copper Smelting, N. L. Warford; Copper Queen Reduction Works, Arizona, C. A. Tupper. *November 13:* What Constitutes the Cheapest Mining? W. H. Storms. *November 20:* Experimental Cyanide Plant of the Michigan College of Mines, C. F. Spaulding; Trumbull System of Topping Plants.

Mining and Metallurgical Society of America Bulletin.—*October 31:* Continued discussion of the report of the committee on standardization.

Mining and Scientific Press.—*October 30:* Planning Mine Equipment, P. B. McDonald; Determination of Mercury in Cyanide Solution and Precipitate, W. J. Sharwood; Hammer Drilling in Colorado, E. G. Snedaker; Natural Taxation of Mineral Land, R. B. Brinsmade. *November 6:* Rock-Drill Bits, P. B. McDonald; Air-Froth Flotation—II.; Trojan Ore and Milling Practice, Jesse Simmons. *November 13:* Sinking the Woodbury Shaft, Michigan, J. M. Broan; Sampling Low-grade Ore on a Large Scale, D. D. Muir, Jr. Electrolytic Precipitation of Gold, Silver, and Copper from Cyanide Solutions, G. H. Clevenger, paper read before American Electrochemical Society. *November 20:* Chrysotile Asbestos, F. H. Mason; Eastern Canada, P. B. McDonald; Cyanide Treatment of Flotation Concentrate, Charles Butters and J. E. Clennell; Pumping at the Commonwealth Mine, Edgar Collins

Teniente Topics.—*October:* Concentrator of the Braden Copper Company; Horwood Process (continued), A. D. Ryan; A Trip to Chuquicamata, B. T. Colley.

NEW BOOKS

The Metallurgy of Gold. By Sir Thomas Kirke Rose. Sixth Edition. Cloth, large octavo, 600 pages, illustrated. London: Charles Griffin & Co. Price 22s. 6d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

Many so-called new editions are merely reprints, with or without trifling alterations and additions. This new edition of Rose's Gold is not one of these. It is practically a new book. Revision and expansion have been on so extensive a scale that the type has had to be entirely re-set. Advantage has been taken of this fact to use a more modern type and a larger page. In writing a few months ago of Sir Thomas Rose's election to the presidential chair of the Institution of Mining and Metallurgy, we expressed the hope that his year of office would be made famous by the dawn of an honourable and lasting peace among the warring nations. In default of this wish being realized, we may fittingly transfer the reference to the issue of this new book, for in it the president has personally made a record of which he may justly be proud, because he has by its publication performed a handsome service to the profession.

Useful technological books may be conveniently divided into two classes, in so far as they appeal to the engineer in search of working details or to the investigator or student desirous of grasping the main lines of operation and the reasons underlying them. This book belongs to the latter class. It consists of an excellent framework of general principles, on which the detailed writings of the specialists may be conveniently hung. As an example we may quote the case of the use of cyanide solution in stamp-mills. The practical man may obtain more help in, say, Caetani's description of El Oro practice, but the general reader finds the guidance of Sir Thomas Rose more useful when desirous of ascertaining the scope and limitations of this system of extraction. The author wisely says that he deals with principles of metallurgy rather than with the mechanical means of carrying these principles into effect.

Sir Thomas Rose has the advantage as an author of knowing all about gold. After obtaining his A.R.S.M., he had some experience of gold-mining and extraction methods in America. For many years he has been at the Royal Mint, and he succeeded the late Sir W. C. Roberts-Austen as Chemist and Assayer at that establishment. It will be seen therefore that his studies have centred on the precious metals, and that naturally his reading has been eclectic. Communications from experts have generously supplemented his personal observations. It is appropriate that a book on the metallurgy of gold should be published in London, the centre of an empire that produces so large a proportion of the world's output, and be written by the man through whose hands so much of the gold passes. We must also say that this appropriateness includes the firm of publishers, Charles Griffin & Co., who not only issue so many of the best known books on metallurgy, but exercise scrupulous care as to their contents.

The first chapter deals with the physical and chemical properties of gold, and the account with illustrations of the crystalline occurrences are of particular interest. In the second chapter the alloys of gold are described and the various equilibrium diagrams fully explained. The third chapter is devoted to the chemistry of the compounds of gold. The next chapter deals with the available information and researches in connection with the distribution and mode of occurrence of gold in nature. Chapters five and six cover placer deposits, and the methods of recovering the gold, by sluicing, dredging, drift-mining, etc. Ore crushing is treated in chapter seven, and amalgamation in chapter eight. In chapter nine other forms of crushing and amalgamating machinery are described, such as steam stamps, Nissen stamps, and various types of grinding and amalgamating pans. Chapter ten discusses fine-grinding problems, with details of the applications of tube-mills, Hardinge mills, and Chilean mills. Chapter eleven deals with concentration plant for the removal of pyritic and other heavy material, and with the classification of sand and slime. Dry-crushing is discussed in chapter twelve, roasting of auriferous ores in chapter thirteen, and chlorination in chapter fifteen. Then we come to the cyanide process, to which are devoted the next three chapters. The information contained is carefully chosen, and the brief explanations of methods and objects are of great interest. The remainder of the book is devoted to the consideration of the refining and parting of gold bullion, and the assay of gold ores, two subjects on which the author is entitled to write with undisputed authority. E.W.

The Mineral Industry: Its Statistics, Technology, and Trade during 1914. Edited by G. A. Roush. Cloth, large octavo, 1000 pages, illustrated. New York: McGraw-Hill Book Co. Price 42s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

This is the twenty-third issue of a notable year-book, as highly prized in England and Europe as in America. It was founded by the late Richard P. Rothwell, and after his death it has been edited by several able technologists, of whom W. R. Ingalls, being one of his associates, maintained the most closely the ideals and objects of the founder. For the last three years it has been prepared by Professor G. A. Roush, of the department of metallurgy in Lehigh University. He has been loyally supported by many of the 'old guard,' and new helpers continually come forward with their assistance. Among the old contributors are Mr. Ingalls, who writes of the metallurgy of zinc; H. O. Hofman, who gives a chapter on recent improvements in lead smelting; James F. Kemp, who this year confines his attention to platinum; J. W. Richards, who writes on aluminium; and R. H. Richards, who gives his usual full records of advances in ore dressing. Of other eminent authorities helping Mr. Roush we may mention L. S. Austin, who deals with the metallurgy of copper; David T. Day, who writes on petroleum and natural gas; Thomas T. Read, whose personal knowledge of China well qualifies him to write on the metals of that country; and F. G. Cottrell, whose system of electrostatic precipitation of fume, already described in our columns, has had such a notable effect in abolishing noxious effluents from smelters. This year there are some new contributors, H. C. Parmelee taking gold and silver, and James Aston iron and steel. We greatly miss the chapters and references to the geology of ore deposits, for which we were accustomed to look. We also regret to find that the references to production and technology are becoming more and more restricted to the United States. Thus we find that the chapter on tin is far from satisfactory, the reason being that as tin is not produced in the United States the trade and technology of the metal are not fully understood by the local writers. It is a pity that the picul should be given as 13⅓ lb. in the table of tin production in the Federated Malay States. The credit for the list of tin mines in Bolivia and their estimated output does not belong to this Magazine, but to the *Engineering and Mining Journal*, whose statistics and information we quoted with full acknowledgment in our Précis of Technology. The chapter on Flotation is puzzling to an English reader, and it is difficult to understand why the writer should claim that Hoover's 'Concentrating Ores by Flotation' gives an "erroneously exaggerated importance to some of the prior art patents." On the other hand the information relating to the companies and their mines that are adopting or trying flotation is of considerable current interest. We are not desirous of finding fault with the volume, for the amount of collected information is of incalculable service to mining engineers and metallurgists, and also to business men interested in metals and minerals. It has always been the wonder to us that records covering so great a range of subjects should be presented in so readable a form and with so few inaccuracies in interpretation.

RECENT PUBLICATIONS.

Canbelego, Budgery, and Budgerygar Mines.—A report by E. C. Andrews, of the New South Wales Geological Survey, on the geology and mines of part of the Cobar copper and gold field. The most important producer of the district belongs to the Mount Boppy Gold Mining company, which is controlled by John Taylor & Sons, and the information given in the report relating to this mine is of considerable interest.

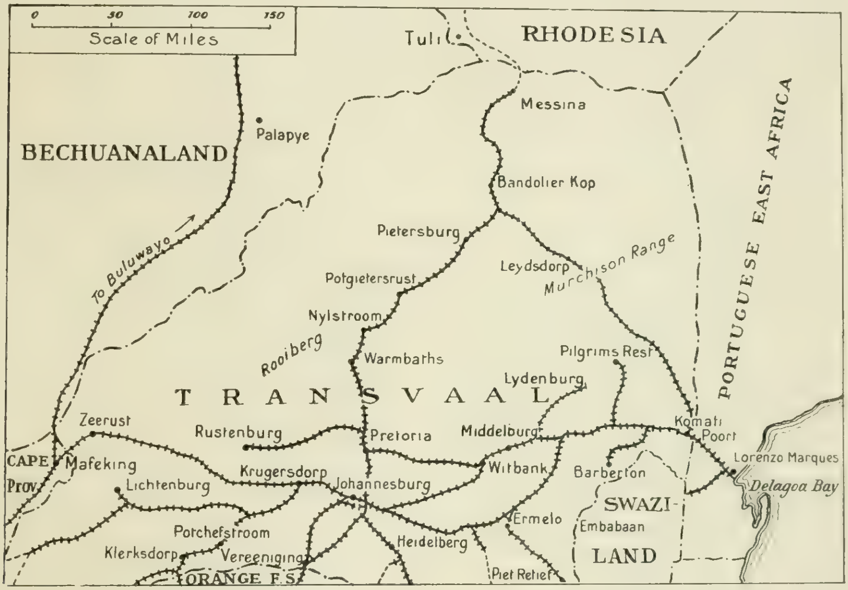
Dredging and Hydraulic Sluicing in Victoria.—The annual report for 1914 of the Chief Mining Inspector gives details of alluvial gold mining during the year. Particulars are given of all the operations and companies, and discussions of the much-vexed problem of damage done to land and rivers.

Ontario Bureau of Mines.—The report for the year 1914 is issued in three parts, of which the first is now to hand. It comprises a general statistical review for the year, a report on mining accidents, and an account of the working mines. In addition special articles deal with the Beatty-Munro gold district, the Michipicoten iron range, the geology and mineralogy of the north shore of Lake Huron, and the metallogenetic epochs of the Pre-Cambrian rocks. We give a précis of the last-named elsewhere. Part 2 is devoted to oil and gas, and Part 3 to the Porcupine district.

Coal Mining in Illinois.—Bulletin 13, by S. O. Andros, entitled 'Illinois Coal Mining Investigations.' A general manual of practice, printed by the State.

COMPANY REPORTS

Messina (Transvaal) Development.—This company was formed by A. M. Grenfell in 1905 to acquire a copper property consisting of ancient mine-workings in the north of the Transvaal close to the Rhodesian border. In the early years the ore was rich and could be hand-picked to over 50% copper. Since then high-grade concentrate has been produced as well as hand-picked ore. The ore and concentrate has been shipped to Swansea. In 1913 small reverberatory furnaces were erected to treat middling, and the resulting matte has also been shipped. Lack of railway communication has caused costs to be high. The extension of the Pretoria-Pietersburg line to the mine was completed in 1913, and during the past year connection has been made with the Silati line, through Leydsdorp to Delagoa Bay. No dividend has ever been paid. Owing to the financial collapse of Mr. Grenfell, in June 1914 the control changed hands, and H. C. Hoover joined the board. The finances of the company were seriously crippled by the fact that a large amount of cash in hand had been placed on deposit with other of Mr. Grenfell's companies. The report for the year ended June 30 last shows that 89,505 long tons of ore was raised, and 1528 tons taken from the dump, the total, 91,033 tons, averaging 7·3% copper. On the picking-belt 790 tons of ore averaging 46% copper was removed by hand-sorting. The remainder of the ore was sent to the concentrator, where 11,327 tons of concentrate was obtained averaging 39% copper. In addition 872 tons of matte averaging 57% copper was produced by smelting middling. The total yield of ore, concentrate, and matte was 12,989 tons averaging 41%, the content of copper being 5330 tons. The income from the sale of these products was £329,282, and the net profit was £130,526. Out of the profit £15,000 was paid as debenture interest, £25,467 was placed to South African profits tax account, £23,304 was written off for capital expenditure on shaft-sinking and railway outlay, and £58,000 was applied to writing down the losses due to funds having been on deposit with Mr. Grenfell's companies as mentioned above. The balance, £8753, was carried forward. During the year A. F. Kuehn was sent to the mine to confer with A. B. Emery, the manager, more particularly with a view to re-estimate the reserve of ore. Correct appraisal of the copper content has always been difficult, as the copper minerals occur in bunches erratically distributed. Mr Kuehn reports the "practically proved ore" at 131,700 long tons averaging 6·57% copper, with "prospective ore in the developed sections above the 10th level" amounting to 43,800 tons averaging 3·67%. A year ago the proved reserve was given at 252,000 tons averaging 8 to 9% copper, with 140,000 probable ore between the 9th and 10th levels.



RAILWAY MAP OF THE TRANSVAAL, SHOWING THE POSITION OF THE MESSINA MINE.

Simmer & Jack Proprietary Mines.—This company was formed in 1887 to acquire property in the eastern part of the Central Rand. The mine has been producing regularly since 1888, and at one time was one of the leading producers, though the grade of the ore has always been lower than at the Robinson and other neighbours on the west. The control is with the Consolidated Gold Fields of South Africa. C. D. Leslie is superintending engineer, and O. P. Powell is manager. The report for the year ended June 30 shows that 817,462 tons of ore was raised, 394,910 tons coming from stopes and development, and 422,552 tons from reclamation on upper levels. After the rejection of 2% waste, 808,300 tons was sent to the mill, where 320 stamps and 7 tubes were employed on the average. The yield of gold by amalgamation was 112,300 oz. and by cyanide 94,302 oz., a total of 206,632 oz., worth £866,619, being an extraction of 5·1 dwt. or 21s. 5d. per ton milled. The working expenses were £533,452 or 13s. 2d. per ton, leaving a working profit of £334,556 or 8s. 3d. per ton. Out of the profit, £300,000 was distributed as dividend, being at the rate of 10%. The mine is now nearing its end. Only a few main blocks of ore remain to be developed, but a large amount of ore left behind in pillars can be reclaimed. The reserve of ore blocked out is calculated at 2,155,000 tons averaging 5·2 dwt. per ton, together with 273,000 tons of partly developed ore having an indicated assay-value of 4·3 dwt., but no estimate can be given of the reclamation ore.

Sub-Nigel.—This company was formed in 1895 to acquire gold-mining property in the Heidelberg district of the Transvaal, containing banket deposits similar to those of the Rand, and assumed to constitute the southern outcrop of the basin of the Far East Rand. The control is with the Consolidated Gold Fields of South Africa. The property is on the dip of the Nigel, which belongs to the City & Suburban group, but it has not enjoyed the same degree of prosperity. An amalgamation was effected in 1909 with the adjoining Nigel Deep, another of the Consolidated Gold Fields group. Nigel Deep had been more successful, and had a plant containing 30 stamps and 1 tube-mill. Dividends of 7½%, 5%, and 2½% have been paid for the years ended June 30, 1913, 1914, and 1915 respectively. The report for the year ended June 30 last shows that 98,760 tons of ore was mined, and after the rejection of 30% waste, 58,470 tons was sent to the mill. The yield of gold by amalgamation was 17,382 oz. and by cyanide 11,458 oz., a total of 27,849 oz., worth £116,680, being an extraction of 9·5 dwt. or 39s. 10d. per ton milled. The working cost was £108,286 or 37s. per ton, leaving a working profit of £8394, or 2s. 10d. per ton. Other items of revenue brought the disposable balance to £11,792, out of which £10,789 was paid as dividend, being at the rate of 2½%. The working cost shows an increase of 60s. 1d. per ton as compared with the previous year. Of this increase 2s. is accounted for by the cost of renewals of plant, and 1s. 9d. for extra development. The additions to metallurgical plant were completed in July last, and for the current year the output should be increased by 30%. The development during the year has maintained the ore reserve, which stands at 194,000 mine tons averaging 7·8 dwt., together with 26,000 tons of partly developed ore having an indicated assay-value of 9·5 dwt. The presence of dikes greatly hinders the development of the western section of the property.

Luipard's Vlei Estate & Gold Mining.—This company was formed in 1888 by the Consolidated Gold Fields of South Africa to acquire a property at Krugersdorp in the Far West Rand. Milling was started in 1898, and after the war, was not resumed until 1906. In 1909 the adjoining Windsor mine was absorbed. The control passed in 1912 to L. Ehrlich & Co., who appointed C. B. Saner manager. The property consists of four sections, two on the Main Reef series, and two on the Battery Reef to the south. Most of the ore comes from the two former. Small dividends were paid in 1908 and 1909. The issued share capital is £472,012, and there are £79,965 debentures. The report for the year ended June 30 shows that operations were greatly impeded by the floods caused by abnormal rainfall during the early part of this year. The levels containing the best ore were not approachable for a time, so that the yield per ton was slightly lower than it otherwise would have been. The working cost was also slightly increased owing to the expenses incurred by the floods. The amount of ore raised was 284,362 tons, and after the rejection of 24% waste, 218,453 tons was sent to the mill. The yield of gold was 51,803 oz., worth £217,147, being 4·7 dwt. or 19s. 10d. per ton milled. In addition, 14,460 tons of accumulated slime was treated for a yield of gold worth £8265, bringing the total yield to £225,413. Other items of revenue brought the income to £237,475. The working cost was £213,823, London expenses £2227, debenture interest £4439, and income tax £2736, leaving a balance of £14,248. From this balance, £11,370 has been written off for depreciation of plant. A large sum was brought forward from the previous year, so that a balance of £125,757 is shown as standing to the credit of the profit and loss account. This balance is mostly represented by additions made during the last few years to the equipment and to the property, and to that extent is not a liquid asset. The ore reserve has been well maintained, and stands at 702,123 milling tons averaging 5·3 dwt., together with 60,000 tons partly developed expected to be of about the same tenor. The development at the eastern section in the Battery Reef has given encouraging results.

Welgedacht Exploration. — This company was formed in 1899 by Ochs Brothers to acquire property in the Far East Rand, on the eastern side of Modderfontein B, containing coal above and gold below. The coal deposits have been developed, and coal has been sold since 1907. In 1905 a bore-hole revealed the existence of banket at a depth of 1908 ft., where the deposit assayed 1 oz. over 10 inches. Shaft-sinking to the banket was commenced in 1910, but at 724 ft. water troubles supervened and sinking was stopped. As the shaft passed through coal at 187 ft. it was utilized for the purpose of assisting in the exploitation of the coal deposits. The report for the year ended June 30 shows that 130,188 tons of coal was sold for £31,057. The profit was £3812, out of which £3526 was paid as dividend, being at the rate of 2½%. David Wilkinson, the consulting engineer, reports that developments at several parts of the coal deposits have been unfavourable, and that bore-holes are being sunk with a view to test other portions of the property. Nothing is being done as regards the gold deposits.

Selukwe Columbia Gold. — This company was formed in 1899, under the name of the Yankee Doodle Development Co., by the Rhodesian Exploration & Development Co., to acquire the Yankee Doodle property in the Selukwe district of Rhodesia. Several reconstructions have been necessary, and in 1911 the control passed to the Gold Fields Rhodesian Development Co. Small dividends have been paid in 1911, 1914, and 1915. Milling started at the Yankee Doodle in 1909 and continued until 1913, when the mine was let on tribute. Other properties were then acquired, the Wonderland, Chimborazo, and Danga, in the Gwelo district farther north. A 10-stamp mill and cyanide plant has been erected at the new properties, and was put in operation in April of this year. The report for the year ended June 30 shows that the plant treated 4371 tons of ore from the commencement of work up to the end of the financial year, and that gold worth £7083 was extracted at a working cost of £7164. The treatment of the concentrate is not satisfactory, but improvements are being considered so that an increased yield per ton may be expected. Development during the year has given encouraging results, and the reserve is estimated at 26,106 tons averaging 11·5 dwt. gold per ton. At the Yankee Doodle the tributers treated 17,125 tons for a yield of gold worth £18,952, out of which the company received £1702 as royalty. The accounts show a profit of £2056, and with £8163 brought forward from the previous year, the balance was £10,219. Out of this £9350 has been distributed as dividend, being at the rate of 6⅝%.

Gaika Gold.—This company was formed in 1902 to acquire gold mining property in the Sebakwe district of Rhodesia, a short distance south of the Globe

& Phœnix. Willoughby's Consolidated and the Rhodesian Exploration & Development were interested in the flotation of the company. The control passed in 1912 to the Gold Fields Rhodesian Development Co. H. A. Piper is consulting engineer. Milling commenced in 1905, and the first dividend was paid in 1911. The report for the year ended June 30 shows that development has continued to be unsatisfactory in depth. In consequence, the sinking of the main shaft in the north section was discontinued at the 10th level, and a smaller auxiliary shaft has been sunk from this level. This auxiliary shaft is down 352 ft. from the 10th level, and 11th, 12th, and 13th levels have been opened. A horizontal dolerite dike 88 ft. thick has been encountered in sinking this auxiliary shaft, and development work has been impeded by it. The reserve was estimated on June 30 at 95,570 tons averaging 14 dwt. per ton, a fall of 5000 tons and ½ dwt. as compared with the figures the year before. During the year ended June 30, the ore raised was 37,514 tons averaging 12½ dwt. and the yield of gold was 20,811 oz. worth £87,465. The working cost was £48,229. After allowing £4562 for depreciation and paying £1124 as London expenses, the net profit was £34,436. Adding £14,920 brought forward from last year, the available balance was £49,357. Out of this, £41,024 has been distributed as dividend, being at the rate of 15%. In order to obtain enlightenment as to the geology of the mine, Professor D. P. McDonald was commissioned to make an examination. By his advice certain prospecting work is being done on the lower levels.

Giant Mines of Rhodesia. — This company was formed in 1903 to acquire from the Enterprise Gold Mining & Estates Co. a partly developed gold mine in Gadzema district of Rhodesia, about 60 miles west of Salisbury. The control is with the London & Rhodesia Mining and Land Co., of which Julius Weil is chairman. Gordon F. Dickson is consulting engineer, and John McDermott is manager. The mine was profitable from the commencement, but in 1912 a fault was encountered on the 7th level, displacing the lode. Though excellent geological advice has been sought, the lode has not yet been recovered. The report for the year ended June 30 shows that milling has been conducted on a restricted scale, 57,086 tons having been treated, as compared with 123,320 tons the year before. The yield of gold was £43,138 as compared with £99,577 the year before. The best year was that ended June 30, 1912, when gold worth £221,405 was obtained from 134,209 tons. During the year under review, the net profit was £10,610, out of which £9312 has been paid as income tax under the new war-profits regulation. The future of the mine depends on the amount of ore that can be saved from caved stopes. Two years ago, the company acquired the Cam-Good Shepherd and Petrol claims from the Cam & Motor Co., which belong to the same control. The work on this new property has been centred on the development of the Cam-Good Shepherd property, and on June 30 the reserve was estimated at 113,982 tons averaging 44s. 7d. per ton. Mining at this property will presumably be commenced when the Giant is exhausted and the treatment plant has been transferred.

Menzies Consolidated Gold Mines.—This company was formed in 1895 to acquire gold mining properties at Menzies, in the North Coolgardie goldfield, Western Australia. The company was reconstructed in 1898, and dividends of 2½% on £225,000 capital were paid in 1914 and 1915. Bedford McNeill is consulting engineer and R. Goninon is manager. The report for the year ended July 31 shows that 28,651 tons of ore was raised and treated, and that the yield was worth £62,857, of which £32,008 was obtained by amalgamation, £19,337 by cyaniding, and £11,512 from concentrate. The net profit was £7151, out of which £5600 has been paid as dividend, being at the rate of 2½%. The ore reserve is estimated at 92,118 tons averaging 40s. 5d. per ton, as compared with 100,818 tons averaging 39s. 9d. the year before. The slight fall is due to development being restricted by the enlistment of miners. The new main shaft has been sunk to 1581 ft., and a 16th level opened. Sinking is to be continued and a 17th level started.

Tolima Mining. — This company was formed in 1871 to acquire the Frias silver-lead mine in the state of Tolima, Colombia. In the early days the operations were highly profitable, but in 1903 and again in 1909 the reserves became exhausted and additional capital was required for development purposes. Since then small profits have been made and the debenture debt has been redeemed. Arthur J. Russell is managing director and John Russell is superintendent. The report for the year ended June 30 shows that the company is suffering from war conditions owing to the English smelters not being able to handle argentiferous lead concentrate. The smelters are under government control as munition works, and only non-argentiferous or antimonial lead is being produced. The company will therefore have to devise means for providing for its financial requirements during the time that the product is unrealizable. The fall in the price of silver has also adversely affected the profits. During the year under review, 14,284 tons of ore was raised, from which 1020 tons of concentrate was produced, assaying 455 oz. of silver per ton. The value of this was estimated at £43,456, but less than half was actually sold on June 30. The accounts show a loss of £2872. The ore reserve is estimated to yield 1715 tons of concentrate.

Pena Copper Mines.—This company was formed in London in 1900 to acquire a copper and sulphur mine in the Huelva district of Spain, that had previously been worked by a Belgian company. The ownership and control has been on the Continent, and Heinrich Schreck is manager. Small dividends were paid from 1903 to 1906. Of recent years there have been difficulties with the Rio Tinto company over the selling and railway contracts, and capital has had to be provided to help to finance an alternative railway route. During the construction of the railway, shipments were suspended, and it was only at the end of August 1914 that they were resumed. The report for the year 1914 now issued shows that during the four months 10,472 tons of cupriferous pyrite was shipped, together with 8532 tons of sulphur ore, and 11,754 tons of leached cupriferous pyrite, being a total of 31,028 tons. The production of copper precipitate was equal to 597 tons of fine copper. The profit on the sale of produce was £7731. Against this £2970 was spent in the London office, £3844 paid as English and French taxes, and £4028 as interest on loans, leaving a debit balance of £2683. At the mine development on the 12th level was continued, and investigations were made with a view to discover the faulted portion of the lode.

Huelva Copper & Sulphur.—This company was formed in 1903 to acquire the Monte Romero and other pyrite mines in Huelva province, southern Spain. Four years ago, H. F. Collins was appointed manager, and he proceeded to erect a copper smelter so as to produce metal instead of relying on the export of pyrite. The report for the year to June 30 last shows that this policy has been to advantage, for in spite of many adverse circumstances connected with the war, the profits have increased. During the year, 49,508 tons of ore was smelted yielding 1222 tons of blister copper. In addition 190 tons of fine copper was produced by the cementation process. The cupreous pyrite exported was only 3549 tons as compared with 18,340 tons the year before. The accounts show an income from the sales of copper and ore of £89,291, and the net profit was £5440. The sale of outlying properties brought £21,178, which has been applied to writing down the loan raised for completing the erection of the smelting plant. The company's finances are now in good shape, and divisible profits may be expected shortly.

Malayan Tin Dredging.—This company was formed in 1911 to acquire alluvial lands near Batu Gajah, in the Kinta district of Perak, Federated Malay States. The company is housed in the same office as the Tronoh and Lahat companies. Nutter & Pearse reported on the property, and F. W. Payne & Co. designed the dredges, which are of the bucket type. The first dredge started work at the beginning of 1913, the second in April 1914, and the third in September 1914. A fourth dredge was delivered on the property in July 1914, but its erection was postponed on account of the war, and it did not start operating until last month. The report for the year ended June 30 last covers two years work of Nos. 1 and 2 dredges, and 9½ months of No. 3. Interruptions of several weeks on No. 1 were caused by troubles with boilers due to dirty feed-water and by damage to the main ladder. No. 3 dredge also suffered from boiler troubles. The amount of gravel treated during the year was 1,967,790 cubic yards, and the production of tin concentrate was 503 tons. The yield per yard was 0·57 lb. The concentrate sold for £44,982. The working cost was £28,804, the London expenditure £1811, allowance for depreciation £2501, and expenditure on transport of dredges to the property £5953. A dividend at the rate of 5% absorbed £6050.

Chenderiang Tin Dredging. — This company was formed in London in February 1914 to acquire the properties of two companies registered in the Straits Settlements, the Chenderiang Valley Tin Dredging Co., and the Jabus Tin Hydraulic Elevators Co. The properties lie in the Chenderiang valley, Perak. The report and balance sheet now issued are for the year ended March 31 last. Since then the dredge built by William Simons & Co., of Renfrew, Scotland, from the designs of M. T. Nelmes Bluck, has started operations, and during the 6½ months to October 31 treated 572,300 cubic yards for a yield of 172 tons of tin concentrate, being an extraction of ⅔ lb. per yard. During the same period, April to October, 44 tons of concentrate was obtained at the hydraulic elevator plant at Jabus.

Briseis Tin & General Mining.—This company was formed in 1899 to acquire tin gravel mines in northeastern Tasmania. Though the output of tin has been large, the divisible profits have not been up to expectation, the total returns being 12s. 9d. per £1 share on a capital of £600,000. Adjoining lower-grade properties, Krushka's Flat and Ringarooma, were purchased later, and also the Wallace gold-gravel property in northeast Victoria. The original property is now practically exhausted, and recent production has come chiefly from Krushka's Flat. The continued dry weather has interfered with sluicing operations and with the development of the Ringarooma property. On the outbreak of war the winning of tin was suspended. The report for the year 1914 just published therefore shows a considerable fall in the output, as compared with the previous year, the Briseis output falling from 42·6 tons to 5 tons and that from Krushka's Flat from 421·5 tons to 128·7 tons. The yield per yard fell 50%, from 3·78 lb. to 1·86 lb. In addition 24·5 tons came from the Ringarooma, and 10·4 tons from Mutual Hill, the total being 197·8 tons averaging 72·3% metallic tin. The fall in the price of tin also had a serious effect on the income of the company. At the Wallace gold property 1,550,800 cubic yards was dredged for a yield of £25,563. The accounts for the year show a loss of £4266. The reserve at Krushka's Flat is estimated at 400,000 cu. yd., containing 470 tons of black tin, and at Ringarooma 7,016,000 cu. yd., containing 4505 tons of black tin.

St. John del Rey.—The interim half-yearly report for the period ended August 31 of this gold mine in Brazil, the deepest gold mine in the world, shows that the output was greater than at any previous period of its history, and that the yield per ton was higher than the average of the last few years. The amount of ore raised was 102,440 long tons, and after the rejection of 3·3% waste, 96,457 tons was sent to the mill. The yield of gold was worth £234,285, being 48s. 7d. per ton as compared with 46s. 3d. the year before. In addition, gold worth £2235 was extracted from old residues. The working cost was £142,950, Brazilian Government duties, etc., £13,852, and allocation to capital expenditure account, £25,000. The 10% preference shares received £5000, and the 546,265 ordinary shares received £20,485, being at the rate of 7½% per annum. Income tax to the extent of £12,687 has been paid, and it has been necessary to keep a large balance of profit in hand, £24,252, out of which excess profits tax will have to be met. George Chalmers, the superintendent, reports that the lode is being developed on Horizon 19 at a vertical depth of 5526 ft. below outcrop by drifts from the bottom of a winze sunk from Horizon 18, and as far as driving has gone, 204 ft., the size and quality of the orebody appears to be satisfactory. No sampling results are as yet available. The cross-cuts from G shaft at Horizons 19 and 20 have been driven 651 ft. and 755 ft. respectively. Considerable further distance will have to be driven before the cross-cuts may be expected to meet the lode.

Aramayo Francke Mines. — This company was formed in 1906 to acquire several groups of tin mines in southern Bolivia, yielding also wolfram, bismuth, silver, and copper, controlled by F. Avelino Aramayo. The report for the year ended May 31 shows that the business of the company was seriously hindered by the war, owing to the difficulty of shipping the concentrates and of finding a market. The smaller amount marketed, the low price of tin, and the increased smelters' charges combined to reduce the income. The mines however were kept at work, though on a smaller scale. The economic outlook for the company has greatly improved during the last few months. The amount of ore treated was 35,774 tons, yielding 2060 tons of tin concentrate, being 5·8% per ton, as compared with 3442 tons from 43,366 tons or 8% the year before. The production of wolfram concentrate was 36 tons, and of copper 39 tons. The yield of bismuth is not published. The profit was £3504, as compared with £135,764 the previous year, but as the year commenced with a balance in hand of £110,364, it was possible to continue the payment of dividends, £44,781 being distributed, being at the rate of 7½%, and £20,000 debentures had been redeemed. The leaching plant at Asllani is completed, and the treatment of rich silver-tin ore will be commenced shortly.